Ancient Versus Modern Health Patterns: Biological and Socioeconomic Status Differences and Similarities Between a Hellenistic and a 20th century Human Burial Population from Greece

By

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To my parents Demetra and Giorgos,
my brother Yiannis, and my grandparents Georgia and Christos

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ABSTRACT

The present research offers the rare opportunity to compare the human remains of an ancient (3rd-1st century BC) population from the North Cemetery of Demetrias, Thessaly, and a modern (late 19th-late 20th century AD) one, the Athens Collection, from various cemeteries in Athens, Greece. Its main purpose is to explore the biological similarities and differences between the two populations and among the subsets within each one of them, as these are defined by biosocial parameters, namely sex/gender, and purely social, that is socioeconomic status. An attempt is made to associate biological with social variation through oral pathology and wear and address questions as to whether the health status of burial populations can indeed reflect socioeconomic conditions and status in life.

Data analysis produced very conclusive differences between the two populations, and among sex/gender and socioeconomic status groups and suggests that dental caries, antemortem tooth loss, occlusal wear and dental enamel defects are very sensitive indicators of social position and conditions in general. Comparisons between the ancient and the contemporary population reveal that environmental, cultural and socioeconomic circumstances did not have the same effect on all oral conditions. Moreover, variations between the sexes are quite evident in Demetrias and they appear to reflect the inferior social position of both women and female infants/children. In contrast, in Athens, there is no evidence to indicate gender discrimination or favourable treatment of male infants. Social class differentiation manifests itself in the distribution of oral pathology and wear between status groups in both assemblages, but it is clearly more pronounced in Demetrias. Finally, this thesis contributes towards a comprehensive understanding of the relationship between biological and socioeconomic status and of the Hellenistic biocultural history. It also emphasises that analysis of human remains should be carefully contextualised culturally, archaeologically and historically.

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PREFACE

This research commenced in 2001 after a year of searching for not previously studied skeletal assemblages all around Greece, and it was at first loosely based around the idea that human skeletal and dental remains can reveal a wealth of information on past life and the inhabitants of Hellenistic Demetrias in particular. When the 20th century assemblage comprising the Athens Collection became available, the exploration of the issues of the association between biological and social status and the differences between ancient and modern human populations were added to the aims of the study. Thus, initially, the intention was to study both skeletal and dental health. Joint disease and trauma were recorded with the aim to infer patterns of daily activity, while dental caries, occlusal wear and periodontal disease were examined in order to detect dietary contrasts. In addition, dental enamel defects were studied with the purpose of investigating differentiation in general health and level of nutrition. Although joint disease and trauma were recorded and data is available, due to space limitations, the results for skeletal pathology and trauma are not discussed in the present thesis. The methodology employed was detailed and the results produced were lengthy, therefore, there was not enough space to discuss all the recorded conditions within the word limit set by thesis guidelines, especially since the aim was to consider these results in depth, making numerous comparisons within an archaeological and historical framework. Thus, it was felt more appropriate to consider oral pathology and wear thoroughly rather than discuss both skeletal and dental conditions superficially. The future intention, however, is to combine the results presented in this thesis with those for skeletal pathology and trauma, in order to reconstruct a more complete picture of the biological status of the two populations.

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The awareness of the fundamental characteristic of humans[1] came very early in my life; while confronting the loss of a loved person I immediately became aware of our mortal nature. This realisation had the impact of an avalache and, overcoming the sometimes disoriented teenager mind, the one eager to set the scope in life, resulted in my choice of studies. My personal "searching within[2]" needed archaeology because through the procedure of literally excavating I found the path to acquire the deep knowledge of people's past lives and societies, focusing finally in interpreting human remains. Researching for this PhD thesis is because I would not want them forgotten; so I draw attention to them, to each and every individual whose remains provide us information about their biological and social status and even more. This is an act of remembering.

After several years of studying this material I have also to remember many people whose essential and gracious support made this journey possible and successful. First and foremost, I would like to express my deep appreciation and sincere gratitude to my primary supervisor, Prof. Simon Hillson, who has supported me throughout my thesis with his invaluable guidance. His depth of scholarship shaped many of my thoughts and widened my perspective. Special thanks should be expressed to my secondary supervisor, Prof. Ken Thomas, for his guidance and thoughtful insight that encouraged me at times when it seemed impossible to master all material gathered.

[1] human from *M. Fr. humain* "of or belonging to man," from L. *humanus,* probably related to *homo* (gen. *hominis*) "man," and to *humus* "earth," on notion of "earthly beings," as opposed to the gods (cf. Heb. *adam* "man," from *adamah* "ground").

[2] "Ἔνδον σκάπτε, ἔνδον ἡ πηγὴ τοῦ ἀγαθοῦ καὶ ἀεὶ ἀναβλύειν δυναμένη, ἐὰν ἀεὶ σκάπτηις" (= Search within. Within is the fountain of the good, and it will ever bubble up, if thou wilt ever dig.) in *Meditations* (*Τὰ εἰς ἑαυτόν*) by emperor Marcus Aurelius.

Spending the years of my PhD research between London and Athens, I benefited greatly from my studies in the Institute of Archaeology at UCL, in particular from the superb library resources and the discussions with many scholars whom I met there and especially with Prof. Tony Waldron, who advised me on several occasions and whose lectures on palaeopathology have been an invaluable tool in my research. I would also like to thank Lisa Daniel, Graduate Programmes Administrator at the Institute of Archaeology, who has helped me on numerous occasions, has gone above and beyond her prescribed duties, and whose assistance and support has been invaluable.

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I owe sincere thanks to the Greek Ministry of Culture and especially the Greek Archaeological Service for the permission to study the Demetrias cemetery material. I would like to thank the scientific and administrative staff of the 13th Ephorate of Prehistoric and Classical Antiquities at Volos (ΙΓ' ΕΠΚΑ) and the Archaeological Museum of Volos. I am gratefully indebted to Mrs Elsa Nikolaou, who gave me her permission to study the osteological material from Demetrias and provided me with information on the archaeological context of the burials. Dr Vassiliki Adrimi-Sismani, Dr Argyroula Intzesiloglou-Doulgeri, Mrs Vassiliki Rontiri, Mr Vassilis Koliopoulos who contributed in the completion of the present research are also deeply thanked.

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Beyond the field of bioarchaeology, the research for this thesis benefited deeply by the encouragement from many others that play a decisive role in my life; my friends that kept my motivation going. My heartfelt thanks are extended to Giorgos who has inadvertently provided me strength and dedication. For their infinite support through all the stages of this research and in general for helping me get through the difficult times, and for all the emotional support, entertainment, and caring they provide in my life I deeply thank Katerina Ntakou-Zamplara and Dr Athanasios Vionis, Maria Konioti and Iakovos Androulidakis who supported my effort to find inner balance at several stressful stages during my research, and who now, with Odysseas, belong to my extended family. The love and care of Euaggelia Grigorakou-Skountjos and Alexandros Skountjos, as well as of Dr Lefteris Sigalos and Tita Prata supported me immensely; especially during my visits in London they provided a hospitable environment in crucial phases of the PhD process. My friends Christina Kiskira, Panos Kambouroglou, Maria Papadopoulou, Marilena Chovalopoulou-Andreas Bertsatos, and Thrassos Stamos are deeply thanked for the major role they have played throughout the PhD period with their personal support and interest. I am also particularly thankful to Kelly Batsi and Fotis Konstantinides for their willingness to provide me with job offers and therefore contribute to my financial independence.

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Chapter 1

INTRODUCTION

1.1 Research Objectives and Overall Hypothesis of the Thesis

This research focuses on two human osteological populations, an ancient (3rd-1st century BC) from the North Cemetery of Demetrias, in Thessaly, and a modern (late 19th-late 20th century AD), the Athens Collection, from various cemeteries in Athens, Greece. Its main purpose is to explore the biological similarities and differences between the two populations and among the subsets within each one of them, as these are defined by biosocial parameters, namely sex/gender, and purely social, that is socioeconomic status. An attempt will be made to associate biological with social variation through palaeopathology and address questions as to whether the health status of burial populations can indeed reflect socioeconomic conditions and status in life.

Certainly, this is a complicated issue as there may not be such a simple correspondence between biological status in death and social status in life. Several studies have detected health patterns suggesting socioeconomic status variation both between females and males and among groups of different social rank (Angel 1984; Lukacs 1996), whereas in other studies, no such diversity was revealed, in spite of an apparently heterogeneous cultural and social setting (Thornton 1991, White *et al.* 1993). This might be so for a number of reasons. For instance, the biological indicators are not always significantly affected by socioeconomic conditions, or even if they are, their sensitivity may not be adequate to reveal fine differences in lifestyle (Robb *et al.* 2001). Other negative factors include non-representativeness of the entire social spectrum in the burial sample and lack of association between grave goods and social status in life.

The present research represents a further contribution to the discussion on the correspondence between biological and socioeconomic status but has an important advantage, which increases the chances of attaining its goal; it considers the issue of this association from multiple viewpoints. This is made feasible, firstly, through comparisons between two chronologically distant populations of particularly diverse environmental, cultural, social and economic backgrounds, and, secondly, by using indicators that are very often thought to denote social standing. These indicators are the grave goods accompanying the deceased in the archaeological assemblage and the occupation of the individuals comprising the modern assemblage. In addition, cultural aspects are considered where necessary, and literary sources and written records of relevant evidence are also taken into account.

The initial thought was to explore the issue of how different the life of an ancient population was, compared to contemporary ones. Archaeologists often pose this interesting question, and they attempt to answer it relying on evidence provided by material culture. The study of the two human skeletal assemblages was seen as a rare opportunity to provide an invaluable insight into this issue based on direct evidence, that is, the remains of the people themselves. Eventually, however, an equally important objective was also set, and that was to consider variation between the sexes and the socioeconomic status groups within each one of the assemblages. The general hypothesis is that differences in socioeconomic status will be reflected in the death assemblages, as the biological status of the two populations is expected to differ since they come from very dissimilar environments. The same is assumed for the sexes, because, in both ancient and 20th century Greece, women were considered socially "inferior" to men (Blundell 1995; Garnsey 1999). In contrast, it is hypothesised that no pronounced differences between socioeconomic status groups will be revealed, although both population samples come from strongly hierarchical societies (Chamoux 2003; Clogg 2002). This assumption is based on the notion that differential mortuary behaviour reflects individual choice rather that social status in life, and that occupation is not a sensitive enough indicator of social class.

Oral pathology and wear are the indicators employed in this research as a means of testing these hypotheses and delving into the aforementioned issues, as they are very much related to diet, nutrition and general health, and they have often shown a strong relationship with socioeconomic factors (Hillson 2003). Therefore, they have a high potential to provide evidence on relative prosperity. Dental caries, antemortem tooth loss, occlusal wear, and periodontal disease are used as the major source of information on diet, dietary habits, subsistence economy, food processing, oral hygiene, and general well-being and how these changed through time and vary according to social standing. Dental enamel defects are associated with exposure to a variety of pathogens, as well as malnutrition, and are recognised as an important indicator of growth disturbances and overall health during growth and their long-term influence in adulthood (Hillson 1996). Teeth can provide a wealth of information on social and economic status, as food highlights social attitudes and relationships in any society, and it is distributed and consumed in accordance with existing hierarchies (Garnsey 1999). Food has been described as "a highly condensed social fact" and there has been a growing awareness of the value of studying its social context and seeing it as material culture by archaeologists (van der Veen 2003). Risk of disease, both during childhood and adult life, has also been linked to socioeconomic position (Smith *et al.* 1998). Futhermore, it is indirectly associated with the nutritional quality of the diet before birth, during breastfeeding and at the weaning stage (Raiten *et al.* 2007), but with other factors as well, including physical care, sanitary conditions, crowding space, and protection by the effects of severe weather conditions (King *et al.* 2005).

In brief, the purpose of the present study is to consider oral pathology and dental wear from a well-defined archaeological and cultural perspective, in order to reach the following aims:

- to explore the issue of the association between biological status in burial assemblages and socioeconomic status in life
- to consider to what extent social position affected diet, nutrition, and health, especially in the Hellenistic period
- to determine the degree of influence of pre-industrial and industrial environment and culture, and address the issue of how different was oral health status in the past
- to consider the matter of influence of sex, as a biologically-determined parameter, and gender, as a socially-determined parameter, on the prevalence, distribution and pattern of caries, antemortem tooth loss, occlusal wear, periodontal disease, and hypoplastic enamel defects
- to address the issue of differential treatment of female and male children in Hellenistic and 20th century Greece
- to identify the differences in the prevalence, severity and pattern of oral pathology and wear between the ancient and the modern population, the sexes and the socioeconomic groups, as well as the variation between subsets in these groups, e.g. between males and females of high social status, between females of low status and females of high social status, etc.
- to reconstruct a picture of the past, and shed some more light on certain aspects of life in Hellenistic Thessaly

Quite obviously, there is no clear distinction among the aforementioned objectives. They are very much interrelated and there is clearly an overlap among them; however, they are presented in such a way that emphasis is given on particular points and on the different approaches of the present work. It should be noted that, due to space limitations, more emphasis is given to the ancient population. The 20th century assemblage is used as comparative material in order to meet some of the aims mentioned above, but as regards the creation of a general picture, and variation between the sexes and the socioeconomic groups, the discussion is far more exhaustive for Demetrias. The rationale behind this decision to focus on the Hellenistic assemblage is that there is very little information on Hellenistic populations, whereas health and socioeconomic conditions in the 20th century are very well known through other sources. In conclusion, the ultimate goal was not to study all pathology present in the populations and have a very general and possibly biased picture of the assemblages, but rather to concentrate firstly, on certain aspects of population biology and make a systematic study that would produce more reliable results, and secondly, on an in-depth discussion of the findings.

1.2 Original Contribution and Significance of the Thesis

Comparisons between modern and ancient burial populations are quite rare. Contemporary osteological collections are very scarce and few similar data sources to the modern collection under study exist for the eastern Mediterranean, or, as a matter of fact, for most parts of Europe and the World. Most of the time, the only picture we have of modern populations is through clinical assessment and radiographic diagnosis in living individuals, which is not directly comparable to osteological populations. This research project provides the exceptional opportunity to compare an ancient and a modern sample of human remains, which are directly comparable. This is, firstly, because they have similar backgrounds, i.e. they both come from industrial and commercial urban centres, economically and politically powerful, and with mixed populations; secondly, because their biological status is compared using the exact same methodology.

The North Cemetery of Demetrias provides a large assemblage in a good state of preservation, in an area of the world where human osteological remains are generally scarce and skeletal population samples from a single time-period are often very small in numbers and not well-preserved; also, little attention has been given to their analysis. Moreover, the present work is the first study of human remains in a site of great archaeological and historical significance. It is worth noting that the assemblage is one of the few comprising such a large number of sexed and aged articulated skeletons from individual burials (i.e. not commingled) that can also be assigned to socioeconomic status groups.

A large number of works on human skeletal remains in Greece has focused on cemetery sites from Macedonia and Southern Greece (Angel 1969; Angel 1973; Papathanasiou 2005; Triantafyllou 2001; Tsilivakos *et al.* 2002). The present research explores the evidence of skeletal remains from an area of Greece, Magnesia, for which very little evidence exists, especially for the historical periods. Most bioarchaeological, and archaeological in general, research to date has been predominantly limited to the Prehistoric and the Classical periods (Angel 1969; Angel 1973b; Papathanasiou 2005; Triantafyllou 2001; Tsilivakos *et al.* 2002) and very little or no attention has been given to the Hellenistic period (Fox 2005). In conclusion, the study of the North Cemetery population of Demetrias will make a significant contribution to the archaeology of the

Hellenistic era of which very little is known, especially in terms of population biology.

1.3 Thesis Structure and Chapter Outlines

Chapter 2 focuses on the hypotheses of the present thesis and the rationale behind their establishment. In order to explain the fundamental reasons that led to the specific assumptions, the biological and social parameters that might have influenced the prevalence, severity, pattern and distribution within the populations under study are discussed. It was thought appropriate to include the sociocultural background of the study areas and time-periods in the *Hypotheses*, rather than in a separate chapter. Thus, the chapter also provides the relevant contextual evidence on the economy and diet, and the position of women, female children, and the lower classes in general and in relation to food distribution in particular, in both Hellenistic and late 19^{th}-20^{th} century Greece. The issue of the meaning and variability of mortuary behaviour and the possible association between mortuary treatment and the structure of differential social status is also considered; grave goods and occupation are evaluated as indicators of socioeconomic status.

Chapter 3 considers the information available on the materials examined and the sites from which they are derived. Information on the topography, geography, geology and climate, and the historical context of the study areas are briefly presented. The archaeological background of the North Cemetery of Demetrias is discussed with regard to aspects relevant to the excavations of the site, the urban history and development of the town, the study of the cemetery, the chronological definition of the burials, and the mortuary evidence. With regard to the Athens Collection, the chapter provides information on contemporary

Greek funerary customs, specimen acquisition and the creation of the collection. Finally, evidence on materials are discussed with reference to the reasons for selecting the specific burial assemblages, the criteria for including individuals in the study, the state of preservation, and the sex and age distribution of each cemetery population sample.

Chapter 4 specifies the methodology employed in detail, with the purpose to clarify the precise meaning of the results presented in this thesis and to facilitate accurate comparisons with other studies in the future. First, information on sex determination and age estimation of the individuals included in the research, the definition of problematic terms used, the assessment of tooth types and dental examination is made available. The methodology for each one of the dental indicators explored is divided into three different sections. In the first, the issue of how each indication meets the aims is briefly discussed. The second part refers to the way each method was planned so as to provide reliable results, whereas the third section indicates the process followed in order to estimate disease and wear prevalence, severity and pattern. At the end of the chapter, reference is made to the comparisons made between Demetrias and Athens and among different subgroups within them, and to the statistical analysis utilised.

In *Chapter 5*, the results of the study are presented in as much detail as possible, taking into account space limitations. Findings are presented in the form of counts and percentages, either in the text or summarised in tables and bar charts. The description of the results is provided for each assemblage (i.e. Demetrias and Athens) and subgroup (females and males, low and high socioeconomic status groups in Demetrias and in Athens) separately, whereas assemblages, sexes and socioeconomic status groups are compared in the *Discussion Chapter*.

Chapter 6 is an in-depth discussion of the results, makes comparisons among samples and attempts to interpret the patterns observed by exploring the archaeological, historical and literary evidence available. Diet, nutrition and overall health are being considered in relation to issues such as ancient and industrial life conditions, sex and gender differences, social status variation, and burial treatment. This approach enables inferences about the social position of females, differential treatment of female and male infants and children, social hierarchy, access to particular dietary regimes by certain segments of society, nutrition and undernourishment, overall health and disease, and so on.

Chapter 7 assesses the most important aspects of the thesis by summarising key findings and discussion points, evaluating the hypotheses, and presenting the limitations and difficulties of the research project. Moreover, the chapter includes concluding remarks related to the questions addressed but also based on the overall outcome of the study, as well as ideas about future potential and further research.

Chapter 2

BIOLOGICAL AND SOCIAL FACTORS AFFECTING ORAL HEALTH STATUS AND SPECIFIC RESEARCH HYPOTHESES

In order to establish the hypotheses to be tested in the present thesis and explain the rationale behind them, it is worth reviewing the risk factors affecting the frequency, severity and distribution of oral pathology and attrition, as well as those biological determinants indirectly influencing these factors. Moreover, due to the fact that certain socioeconomic and cultural conditions also affect oral health, a general picture of Hellenistic and late 19th-20th century Greece from the various historical and archaeological sources is reconstructed, emphasising those social parameters that indirectly influence these factors.

2.1 Risk Factors Affecting Oral pathology and Wear

2.1.1 Dental caries and periodontal disease

Dental caries is a disease process characterised by the progressive demineralisation of dental hard tissues, i.e. enamel, cement, and dentine. It is the cumulative effect of changes in the pH environment of dental plaque deposits on the surface of the teeth. The pH varies during the day and caries is a result of this variation and overall imbalance of low and neutral pH episodes. If low pH phases predominate, a lesion of caries develops (Hillson 2008, 111). This process, its frequency, severity, and distribution among and within skeletal populations, is influenced by a wide variety of interacting factors.

More specifically, teeth are covered by bacteria, which constitute the dental plaque (Loesche *et al.* 1973; Loesche & Role 1986). Certain of these bacteria, such as the mutans streptococci (which includes *Streptococcus mutans* and *S. sobrinus*) and lactobacilli are acidogenic. That is, they produce acids when they metabolize fermentable carbohydrates (Loesche & Role 1986). These acids, such as lactic, acetic, propionic and formic acid, can dissolve the calcium phosphate mineral of the tooth enamel or dentine (LeGeros 1991). If this process is not halted or reversed, the carious lesion progresses, eventually leading to a cavity. Any fermentable carbohydrate such as glucose, sucrose, fructose, or cooked starch, can be metabolized by these bacteria with the evolution of organic acids (e.g., acetic, lactic, propionic) as by-products (Geddes 1975). The acids diffuse through the plaque and into the porous enamel (or dentine if exposed), dissociating to produce hydrogen ions as they travel. The hydrogen ions readily dissolve the mineral, freeing calcium and phosphate into solution, which can diffuse out of the tooth. This is demineralization, or loss of mineral (Featherstone 1999, 32).

Gingivitis is characterised by inflammation of the periodontium, which causes gum recession. This results in the formation of pockets between 3·5 and 5·5mm between the tooth surface and the gum (Nuttall *et al*. 2001). Advanced periodontitis is distinguished by excessive tissue loss of the gingiva and alveolar bone and pockets greater than 5·5mm in depth. This condition often leads to tooth exfoliation due to the destruction of the tooth connective ligaments (Chapple *et al*. 1997). The aetiology of periodontal disease is believed to be an imbalance in the bacterial species that colonise the oral cavity, and the host immunological response to these bacterial pathogens (Lamont & Jenkinson 1998; Sculley & Langley-Evans 2002).

Plaque

Hillson (2008) emphasises the role of plaque but makes a clear distinction among plaque bacteria, matrix and fluid, as correlated but distinct factors affecting caries occurrence. Plaque, which covers exposed tooth surfaces, is inhibited by many different species of bacteria, which form a deposit that represents a complex "bacterial ecosystem" (Powell 1985, 313). These species rise to dominance depending on the environment (pH, oxygen, etc.) in which the deposit finds itself (Hillson 2008, 113). Certain types of tooth surfaces are more susceptible to plaque formation than others, because they are not as well cleansed by mechanisms of the mouth, such as saliva flow (Batchelor & Sheiham 2004). This differential susceptibility results in higher frequency rates in occlusal sites than in contact areas and root surfaces; this pattern is more evident in young individuals, whose contact and root surfaces are not exposed. The plaque matrix holds the plaque deposit together and it is made from bacteria and components derived from saliva. Plaque deposits have a surface membrane within which, is the plaque fluid. The pH balance of the plaque fluid, which varies from surface to surface, is responsible for the development of caries (Hillson 2008, 114).

Microbial dental plaque has been strongly associated as a causative agent for gingivitis. However, the association of supragingival plaque with periodontitis is not clear. It appears that supragingival plaque may provide a favourable environment for colonization with specific subgingival flora and indirectly affects the pathogenic subgingival flora (Genco 2000). Calculus in patients receiving regular dental care does not result in significant periodontal disease. On the other hand, studies report a high correlation between measures of calculus and measures of periodontal disease. Calculus is likely a deposit that forms after periodontal disease develops and contributes to progression of periodontitis by providing a nidus for microbial plaque accumulation and persistence (Genco 2000).

Saliva

Saliva flow rate and chemical composition are physiological features that have a decisive role in caries epedimiology. Saliva's significance lies in the fact that it provides lubrication of the oral cavity, washing away cellular debris and sugars, but also because it has a buffering action that promotes oral health by denying bacteria an optimal environmental pH, and by neutralising acids produced by bacteria, thus preventing demineralisation and cavitation of enamel (Dowd 1999). Moreover, saliva has antimicrobial action (Marsh 1999) and an important role in the digestive process, initiating the breakdown of starch. It also assists in posteruptive maturation of enamel, thus promoting caries resistance (Lukacs & Largaespada 2006, 545-547).

Periodontal disease is a chronic bacterial infection characterized by persistent inflammation, connective tissue breakdown and alveolar bone destruction. Contributing inflammatory mediators and tissue destructive molecules have been detected in the gingival tissues and saliva of patients affected by periodontitis. Thus, saliva should contain biomarkers specific for the unique physiological aspects of periodontitis, and qualitative changes in the composition of these biomarkers could have diagnostic and therapeutic significance (Miller *et al.* 2006). Moreover, the available evidence implicating inflammatory mediators and cells in the disease process suggests that local (salivary) antioxidant status may be of importance in determining susceptibility to the disease and its progression following initial bacterial colonisation (Sculley & Langley-Evans 2002).

Tooth morphology and size, nature of dental tissues, attrition, and occlusion abnormalities

The morphological features and size of teeth affect their susceptibility to caries. Posterior teeth (premolars and molars), especially molars, which are larger and more complex morphologically, display significantly higher frequencies of carious lesions than smaller and less complex anterior teeth (incisors and canines) (Hillson 2000). In addition, particular points on the crown, such as mesial and distal contact points between teeth or fissures and pits on the occlusal surface, are more predisposed to caries than other sites of the crown (Batchelor & Sheiham 2004; Hillson 2001).

Enamel integrity is also an important factor affecting caries prevalence and severity. Teeth are at their most vulnerable when they first erupt, because enamel is not completely mineralised at this stage, and are thus more susceptible to caries attack (Hillson 1996). In addition, it has been suggested that developmental enamel defects increase the risk of caries in the affected teeth (Hong *et al.* 2009, 345). Hypoplasia or hypocalcification sites provide a suitable local environment for colonization of cariogenic bacteria, which come into contact with the exposed dentine, and thus caries on these sites may develop more rapidly (Li 1996). Several studies have shown that there is an association between enamel defects and caries (Daneshkazemi & Davari 2005; Montero *et al.* 2003; Oliveira *et al.* 2006).

The amount and rate of dental wear in a population may also directly influence prevalence and severity of caries (Albashaireh & Al-Shorman 2010). Slow rates of wear may be favourable, in that they remove potential caries loci from occlusal surfaces or tissue affected by lesions, by smoothing out fissures and pits. Nevertheless, it creates new sites at which caries can develop, such as the vulnerable cemento-enamel junction and the root surfaces, which get exposed above the gingivae when continuous eruption takes place, as mechanism to keep teeth in occlusion as wear progresses (Hillson 2000; 2008, 113). Mesial and distal contact points may also become more at risk, as inteproximal spaces may be enlarged by the process, promoting entrapment of food particles and thus increasing cariogenic bacterial activity at these particular regions (Powell 1985, 309). Furthermore, there is evidence that the cement coating the root surface is less resistant to caries than the enamel of the crown.

It has also been suggested that malocclusion predisposes to periodontal disease, especially with regard to crowding, primarily because it seems likely that certain morphologic traits of malocclusion may impede oral hygiene and self cleaning and, thus, lead to increased accumulation of bacterial dental plaque (Helm & Petersen 1989). Pre-industrial groups masticating hard foods possessed edge-to-edge bite, whereas industrial groups consuming soft foods have high frequencies of occusal abnormalities and crowding (Larsen 1995); thus, the latter are more predisposed to periodontitis.

Genetic predisposition

Genetic predisposition does not constitute a separate factor affecting caries prevalence. Rather, some of the factors previously discussed, as well as some others, are biologically determined or, at least, influenced. Hassell and Harris (1995, 326) indicate that caries rate in humans is a consequence of five distinctly separate traits or attributes: the structural integrity of dental enamel, water fluoridation, the composition of saliva (Mandel 1974), attrition and dietary habits, and oral bacterial flora (Goodman *et al.* 1959) and personal and professional oral hygiene. Enamel integrity and saliva composition are directly genetically influenced; attrition and propensity for diet (Forrai and Batnkdvi 1984), and oral flora less so; and water fluoridation is purely environmental. Some additional genetically variable factors which may be involved in the development of caries are reported in the research paper by Boraas *et al.* (1988), and these include: tooth eruption and sequence (Finn & Caldwell 1963; Gedda & Brenci 1966), tooth morphology (Konig 1963; Wood & Green 1969; Biggerstaff 1973), arch shape (Kolmakow & Puranen 1985), dental spacing, arch size and shape, overjet, overbite, and rotated teeth (Corruccini & Potter 1980).

Genetic factors also affect periodontal disease and can be subdivided in (a) abnoramlities of the teeth, affecting size, shape, and number of teeth, enamel and dentine defects, and abnormalities in dental pulp, (b) genetic abnormalities affecting the craniofacial complex, and (c) genetic factors associated with periodontal disease (Genco 2000, 20).

<u>Oral hygiene</u>

Poor oral hygiene is also involved in caries aetiology, as it "leads to bacterial overgrowth: the amount of bacteria in the dental plaque reaches 10^{11}/ml in individuals with poor hygiene, which is a risk factor for caries development" (Delgrado-Darias *et al.* 2005, 560). A considerable number of research studies (Axelsson & Lindhe 1981; Krawczyk & Mielnik-Baszczak 2002; Levin & Currie 2010; Loe 2000; Milgrom *et al.* 2000; Polk *et al.* 2010) have provided evidence that efficient oral hygiene, both personal and professional, has a caries preventive effect. A study by Nyvad and Fejerskov (1986) on active root surface lesions showed that, after a period of two to six months of careful toothbrushing with a fluoride toothpaste, all lesions gradually became inactive. The preventive effect obtained from professional tooth cleaning however, contrasts the moderate and variable results by self-performed oral hygiene (Bellini *et al.* 1981).

The association between oral hygiene and periodontal disease still remains unclear. A relationship between oral hygiene and periodontitis has been demonstrated in several studies (Greene 1963; Jain *et al.* 2009; Socransky 1970). The results of other studies, however, have revealed that the subgingival microbiota did not change with an enhanced bacterial colonization, and that the counts of bacteria associated with periodontitis did not increase (Baumgartner *et al.* 2009).

Fluoride consumption

Fluoride has a protective effect against caries (Hellwig & Lennon 2004; Limeback 1999). Fluoride in drinking water, occurring naturally or artificially, and fluoride-containing products, such as toothpaste and mouthwash, reduces tooth decay via three mechanisms: (a) inhibition of demineralisation at the crystal surfaces inside the tooth, (b) enhancement of remineralisation at the crystal surfaces, and (c) inhibition of bacterial activity (Featherstone *et al.* 1990; Hamilton & Bowden 1996). Slightly elevated levels of fluoride in saliva and plaque help prevent and even reverse caries by inhibiting demineralisation and enhancing remineralisation (Featherstone 1999, 31-32). More recent data indicate that the relationship between sugar consumption and caries is not as strong as it was in the prefluoride period (Zero 2004, 282-283).

Diet

The relationship between diet and dental disease was first recognised in antiquity. Aristotle noted that soft sweet dried figs adhered to the teeth and were associated with caries, whereas Galen believed caries to be an inflammatory response to “excessive nutrition” (White 1975 cited in Powell 1985). The strong correlation between diet and dental caries is today widely accepted (Lingstrom & Borrman 1999).

Most proteins and fats have little effect on the plaque and are metabolised by bacteria, whereas milk products, especially cheese, seem to be associated with the prevention of caries and have the potential to remineralise carious enamel (Yoshihara *et al.* 2009). The dietary components that contribute most to the caries process are fermentable carbohydrates. These need to be retained in the mouth long enough to be metabolised by oral bacteria, principally *Streptococcus mutans* but others as well, to produce acid, which will then attack the tooth enamel and gradually dissolve it. This demineralisation process is offset by remineralisation, which is the repair process. The balance between these two processes determines whether caries occurs (Hillson 1979). Extensive data exists to show that any foodstuff or drink containing fermentable carbohydrate has the potential to cause significant acid production, leading to the demineralisation of the enamel (Karjalainen 2007; Lingstrom *et al.* 2000; Llena & Forner 2008). The link between plaque acidity (pH) and cariogenicity depends on the extend of the drop in plaque pH but the duration of plaque acidity is also very important. Duration can be infuenced by the frequency of carbohydrate consumption, rather than its amount (Lingstrom *et al.* 2000).

Carbohydrates consist of sugars, short-chain carbohydrates, starches, and non-starch polysaccharides. Short-chain carbohydrates and non-starch polysaccharides are unlikely to be fermentable by bacteria (Lingstrom 2000). Sugars are small molecules that diffuse directly into the plaque fluid and are rapidly fermented by bacteria (Hillson 2008, 115). All dietary sugars are potentially cariogenic but sucrose seems to be both the most strongly related to caries, and the most commonly consumed sugar and major diet component in industrialised societies (Cury *et al.* 2000). There are also sugars that are naturally present in honey and fruits. Starches have also been shown to cause significant acid production and to thus contribute greatly to the caries process (Kashket *et al.* 1994; Mundorff *et al.* 1990; Pollard 1995). However, the cariogenicity of starch products depends on the innate make-up of starches and the widely varying conditions of food processing (van Loveren & Duggal 2004, 21). High levels of caries have been noted with diets consisting of different starches, e.g. sago or rice (Edmondson 1990).

The cariogenic potential of sugar-containing foods and starches can be modified by several factors, which include the amount and type of carbohydrates (sucrose vs. other sugars or sugar/starch combinations), protective components (protein, fats, calcium, phosphate, fluoride), and physical and chemical properties (pH, buffering capacity, solubility, liquid vs. solid, retentiveness) (Zero 2004, 281). It is also influenced by the consumption pattern, most importantly the frequency of consumption (Bowen *et al.* 1980), the texture of food (Larsen 1997), food preparation techniques (Cucina & Tiesler 2003, 2), and cultural and economic factors (availability and distribution; selection, and marketing) (Edgar 1985). Controlled human experiments provided evidence that carbohydrate intake is also associated with periodontal disease (Cheraskin & Ringsdorf, 1963).

Moreover, calcium concentration and vitamin C play an important role in maintaining the health of the gingiva (Genco 2000; Lapido 2000).

2.1.2 Antemortem tooth loss

Antemortem tooth loss (AMTL) is a complex and multifaceted process that involves dietary texture, nutritional deficiency diseases, oral health status, traumatic injury and cultural practices (Cucina & Tiesler 2003; Lukacs 2007). Firstly, abrasive foods may cause severe attrition, resulting in pulp exposure, dental abscess, and ultimate tooth loss. Secondly, soft foods and refined diets, high in carbohydrates, may encourage development of large caries lesions, producing pulp exposure, abscess formation, and finally tooth loss (Lukacs 2007). Thirdly, periodontal disease and alveolar recession may ultimately result in tooth loss (Koritzer 1968 cited in Lukacs 2007).

2.1.3 Occlusal wear

Occlusal wear is a multifactorial process and a result of dietary or daily task activities (Deter 2009; Watson 2008). Dietary enamel loss may occur from the intentional ingestion of food items, such as the fibrous elements and acidic foods in a diet, or the unintentional ingestion of abrasives, such as sand or grit that can contaminate food during preparation (Hillson 1979; Kieser *et al.* 2001; Molnar 2008). Nondietary wear can be caused by using the teeth as a tool, from bruxism, or through erosion from chemical dissolution of the tooth surface by intrinsic (gastro-oesophageal reflux) factors (Deter 2009). However, dietary composition and food processing methods have the greatest affect on patterns of occlusal surface wear observed in nonindustrial societies (Watson 2008).

2.1.4 Dental enamel defects

"Growth of the tooth enamel commences at the incisal or cuspal terminus of the crown and proceeds in a uniform fashion to completion at the cementoenamel junction. The enamel is first laid down by ameloblasts (enamel-producing cells) secreting a highly proteinaceous matrix. The matrix mineralises into an acellular material composed mostly (> 97%) of inorganic salts, thus forming the fully mature enamel. The enamel matrix is deposited in a series of structural increments demarcated by striae (or lines or bands) of Retzius" (Larsen 1997, 43-44). This regular process is subject to factors that may either slow or even stop enamel growth. Enamel is especially sensitive to metabolic insults arising from nutritional deficiencies or/and disease. Any factor leading to metabolic disturbance will result in visible changes in the structure of enamel, i.e. dental enamel defects (DDE).

The aetiology of DDE is multifactorial (Rose *et al.* 1985) and therefore, DDE have been regarded a non-specific indicator of growth disruption. Some of the factors contributing to the presence of DDE are malnutrition, infectious disease, genetic anomalies, diabetes, allergies, trauma, infections, neonatal disturbances, psychological disruption and genetic background (Rose *et al.* 1985; King *et al.* 2002; Littleton 2005; Zhou & Corruccini 1998). In other words, enamel defects in a population are more likely to occur due to a complex interaction of different factors.

2.2 Biological Determinants and Social Parameters Influencing Risk Factors

The aforementioned risk factors might be indirectly infuenced by other biological determinants and social parameters, which indirectly influence oral pathology and wear prevalence, severity, pattern and distribution. The biological determinants are related to sex differences, whereas the social parameters are associated with the cultural and socioeconomic conditions of the societies under study.

2.2.1 Biological determinants

2.2.1.1 Sex differences in the immune system, morbidity and mortality rates

The human immune system manifests some degree of sexual dimorphism with basic immune responses differing between females and males. However, the significance of this difference in favour of females remains poorly defined since there do not appear to be significant differences in susceptibility to infection or inflammation degrees between the sexes (Lleo *et al.* 2008, 627). Maternal immunosuppression, however, results in gestational vulnerability to pathogens. This occurs because "pregnancy brings two dichotomous objectives into conflict. One the one hand, pregnancy necessitates harbouring a foreign body, since half of the genetic material of the developing organism is paternally derived. On the other hand, the immune system identifies and attacks foreign bodies. Accordingly, pregnancy can occur only if maternal immunological defenses are initially restrained" (Fessler 2002, 25). Consequently, women are vulnerable to infections, during pregnancy. Sex-specific cariogenesis in particular, is strongly associated with suppression of the immune system during pregnancy (Lukacs 2008) and also, pregnancy-related changes in blood volume, oestrogen and progesterone ratios, decreased maternal stomach capacity and insuline insensitivity (Cheyney 2007, 87).

Males have substantially higher mortality than females at all ages (Roberts *et al.* 1998; Stini 1990). Although the magnitude of the male disadvantage varies depending on environmental, social, and economic conditions, women live longer than men in all the technologically developed countries and almost all other countries of the world, even in cases where there is a bias in access to nutrition and health care (Austad 2006). Several explanations for women's longer lifespan have been proposed and these include: (a) the stronger female immune response, (b) the protective effect of oestrogen in females at a cellular level, (c) the advantage of having two X chromosomes, (d) the reduction in the activity of growth hormone in females, and (e) sex differences in oxidative stress production (Austad 2006). Although no consensus has emerged on the aetiology of sex differences in mortality rates, there is no question that women outlive men across cultures and conditions.

The female advantage in survival has been evident since the 18th century, and, as living conditions for women improved, the gap between the sexes increased in the first three quarters of the 20th century in most Western countries. In the last quarter of the 20th century differences in life expectancy narrowed in most European countries and the U.S., but became larger in other countries, namely Greece, Hungary, the Russian Federation, and Japan (Oksuzyan *et al.* 2007, 92). Nevertheless, the male disadvantage remained. In archaeological populations however, the opposite pattern is the norm, with females exhibiting higher frequencies of deaths, especially during early adult years but also in the older age groups (50+ years). Peak female mortality is typically present in the early adult years, and the rates of female deaths remains higher up to the early 30s (Slaus 2000, 194). Deaths in these age groups are related to increased risk caused by complications of pregnancy and childbirth (Armelagos 1998). In the course of history, it was not the biological differences between the sexes that underwent modification, but rather the respective status of the sexes, and mortality conditions changed accordingly (Acsadi & Nemeskeri 1970, 186).

Changes in the size of male disadvantage in life expectancy can be partially attributed to sex differences in infant mortality (Bouman *et al.* 2005) and early (under five years of age) childhood (Goodman & Armelagos 1988). Because females have more vigorous immune responses and greater resistance to infection, female infants have lower mortality from infections and respiratory ailments (Read *et al.* 1997). The male disadvantage begins *in utero* (Mc Millen 1979) and that is the reason males are more likely to be born prematurely and suffer from respiratory conditions (Zeitlin *et al.* 2002).

Unlike adult mortality, explanations for sex differences in infant mortality are dominated by biological rather than lifestyle factors. A study by Drevenstedt *et al.* 2008, examining the changes in the size of the male disadvantage in fifteen countries, from 1751 to approximately 1970, showed that, unlike adult mortality, explanations for sex differences in infant mortality are dominated by biological rather than lifestyle factors. The view that biology is the prominent factor in sex mortality differences, especially in the first year of life, is supported by other studies (Eshed *et al.* 2004; Waldron 1983; 1998) as well.

This male disadvantage is of particular interest for this study. Since it is mainly attributable to biological factors, such as immunosupression caused by testosterone and greater male suseptibility to infections (Oksuzyan *et al.* 2007), the same sex-difference in infant and childhood mortality is likely to have existed in ancient populations. However, female infants and children may, at least in some cases, have had less access to resources than their male age-peers (King *et al.* 2005). Thus, although girls are more biologically resistant to growth disruption, decreased food allocation may have favoured boys (Goodman & Armelagos 1989).

So, although mortality partly depends on biological factors, it also varies with socioeconomic status and behavioural patterns (Chamberlain 2006), which may differ from society to society. In modern Western societies, men are more likely to take risks that may negatively affect their health, such as smoking and drinking, and women are more likely to engage in preventive behaviours designed to preserve or improve their health, such as healthier diet / better nutrition and regular visits to the doctor (Waldron 1983). Moreover, more men are employed and, on the average, men's jobs are more hazardous than women's. Accidents on the job are a major cause of men's higher accident rates. Men's greater exposure to carcinogens also contributes to men's higher mortality rates (Waldron 1983).

For populations of the past, there is a growing body of bioarchaeological evidence, which has associated differential status between females and males, and childhood growth disruption with reduced life expectancy (Duray 1996; Goodman & Armelagos 1989; Mittler & Van Gerven 1994). Stable isotope analysis in some populations suggests a nutritional difference between the sexes, which is the result of females consuming less protein than males, indicating preferential treatment of males (Fuller et al. 2006; Kinaston et al. 2009; Muldner & Richards 2007). Undernutrition and infection in any population or population subgroup, impair morphological development in children, and impact adult morbidity and mortality in this particular group, through metabolic imprinting and impaired immune response (Slaus 2000, 195).

Considering all the above, sex-differences in the immune system, in the susceptibility to disease and in mortality rates would indirectly influence the distribution of oral pathology between the sexes in the populations under study. For instance, a more vigorous female immune response would most likely result in higher growth disruption levels for the male population, unless there was preferential treatment for male infants/children. The susceptibility of women to oral pathology, during pregnancy, would be evident in significantly higher rates of caries and periodontitis in females in the younger age group. The longer lifespan of females would contribute, along with other factors, to higher caries and antemortem tooth loss frequency, in the modern assemblage, whereas, in the archaeological assemblage, this difference is expected to be smaller due to the fact that males outlived females in the ancient population. Moreover, these biological sex-differences should be taken into account as they may provide an insight into the possible reasons behind the oral pathology patterns between populations and within population subgroups. The possible effect of these differences will be further discussed later in this chapter.

2.2.1.2 Sex differences in saliva composition and flow rate, and the effects of hormones

Recent studies have emphasized the critical role of female hormones and life-history events in the aetiology of dental caries and suggest that hormonal fluctuations can have an effect on the oral health of women (Lukacs 2008; Lukacs & Largaespada 2006). Throughout the life history of an individual, hormone levels fluctuate on a daily basis. Hormones coordinate the way tissues and organs function. Gonadal steroid hormones primarily target reproductive systems of both sexes. Males and females both have different levels of two key groups of gonadal steroid hormones and these are oestrogens and androgens (Vines 1993). Oestrogens are found in higher levels in females, whereas androgens are found in higher levels in males. Oestrogen levels peak in women monthly in response to the menstrual cycle, and also during certain life-history events, such as puberty and pregnancy (Dural & Cagirankaya 2007; Lukacs & Largaespada 2006). Research has showed that caries rates increase proportionatelly with increasing oestrogen levels, whereas androgens appear not to have any effect (Liu & Lin 1973).

The quality and quantity of saliva interact synergistically and have a significant impact on oral health (Tenovuo 1997, 1998) and, since saliva flow is the medium that brings protective agents into the oral cavity, qualitative factors are dependent on quantitative factors (Lukacs & Largaespada 2006, 548). The quality and quantity of saliva, however, differ between the sexes, with females having a significantly lower mean saliva flow rate than men (Percival et al. 1994). This difference becomes even more pronounced during menstruation, in puberty but more significantly, during pregnancy (Laine 2002). Hormonal changes during pregnancy increase the susceptibility of gum tissues to local irritating factors and inflammatory processes. An increased concentration of oestrogen in the saliva produces more epithelial shedding, creating an environment propitious to bacterial growth (Arantes *et al.* 2009). Levels of bacteria rise and the saliva has a lowered pH and buffering capacity. The concentration of calcium and phosphate is slightly lowered during pregnancy, which may affect the remineralization of initial caries lesions (Arantes *et al.* 2009). These changes alter unfavourably the organism's capacity to resist the various risk factors for caries and gingivitis (Laine 2002).

Vadiakas and Lianos (1988) examined the correlation between caries and pregnancy and noted that, in addition to changes in the mouth flora and saliva, there are another three factors that appear to be highly significant during pregnancy, namely vomiting, neglected oral hygiene, and nutritional changes. The latter relates to food cravings and aversions during pregnancy. Common cravings include sweet (e.g. honey) and sour (e.g. citrus) which are aetiological agents for caries and dental erosion (Vallianatos 2007).

Another factor affecting caries rates is the fact that females' teeth erupt earlier than the males' and are therefore exposed to the cariogenic environment for longer early on in life, when teeth are still not completely mineralised (Hillson 1996, 2000; Larsen 1997). Clinical and epidemiological studies of large samples of 7 to 12 year-old children (Mansbridge 1959) and 12 to 17 year-old adolescents (Haugejorden 1996), consistently found that females experience caries more often than males from an early age, with girls displaying significantly higher frequencies of caries, missing and filled teeth. However, sex differences in the timing of dental emergergence have been shown not to play a significant role in cariogenesis (Mansbridge 1959).

Periodontal disease, in contrast to caries, is regularly reported to be more prevalent in males, even when correcting for oral hygiene, socioeconomic status, visits to the dentist, and age (Grossi et al. 1994). This difference between the sexes is most likely the result of the effects of hormones and more particularly the female hormone oestrogen, which protects against the destructive periodontal bone loss (Grossi et al. 1995).

2.2.2 Social parameters and diet/nutrition

2.2.2.1 Hellenistic Greece

Because dental caries and periodontitis, and malnutrition and infection resulting in dental enamel defects, are not the result of dietary intake only, we should not expect to find a precise correspondence between the hierarchy of dental health and social hierarchy. Nevertheless, sociocultural attitudes are expected to be reflected in the distribution of dental pathologies between broad social divisions, such as “upper” and “lower” social classes and men and women. In Greek society, food was a marker of ethnic and cultural difference. In the literature from antiquity, Greeks were differentiated from barbarians, urban-dwellers from rural populations, farmers from nomads, and so on, in terms of the food they ate, amongst other things. Within the family, the distribution of food might be expected to be an index of relative power and status, as between male and female, parents and children, young and old. Food also reflected the vertical social and economic distinction between rich and poor (Garnsey 1999, 6).

2.2.2.1.1 Social hierarchy and food allocation

Political and social structures greatly influenced the foods eaten and styles in which they were consumed. The conspicuous consumption of food in ancient Greece was an important manifestation of wealth, status, and power. "This was appropriate in a social context where food was a relatively scarce, highly valued and unequally distributed commodity. Food, then, was a vital concern in the advanced societies of antiquity, much more so than is now the case in the developed West, which has long since slipped the net of famine, food shortage, malnutrition and hunger" (Garnsey 1999, 3). A very important consideration would thus be the distribution of food between low and upper social classes, its quality, as well as the way it was processed.

Most people consumed food they had themselves produced and the main aim was self-sufficiency. However, self-sufficiency was not always attainable. Either the environement was not suitable for the production of some commodity or there were deficits left by bad harvests. The majority of ancient populations lived the hard life of the subsistence farmer or landless labourer, which was insufficient to guarantee enough food for the family unit in all years. Supplies were not guaranteed and quality might often be poor for the largest part of the population (Wilkins & Hill 2006, 51-52). It was generally the case that when food supplies to the population were threatened, which was not rare (Scheidel 1995), food shortages tended to hit the countryside before the town and the poorer before the richer (Galen cited by Grant 2000; Garnsey 1998).

There were common people though, mainly city-dwellers, who were not themselves engaged in farming. Market forces brought food to the cities, ensuring that these people could buy what they needed much of the time. The mass of ordinary urban residents, however, had little purchasing power. Their resources of wealth were minimal, and there was no guarantee of regular employment in a city. An additional problem lay in the variability of supply, and the large fluctuations in price that inevitably followed even small fluctuations in the quantity of available foods in a pre-industrial society (Garnsey 1999, 32).

Greater purchasing power of the upper classes on the other hand, gave access to foods of superior quality and quantity, and of wider range (Wilkins & Hill 2006). Poorer people were more likely to eat the products of local agriculture, while the rich were able to supplement the traditional diet with imports. Trade brought to cities both exotic food items and spices or variants on what was locally available, such as wheat and wines. These were likely to attract the attention of members of the wealthy elite, who were also the only ones who could afford to purchase them. Imports of goods that were also locally available might be required if a poor harvest threatened indigenous supplies, or if an imported variety was perceived to be of finer quality (Wilkins & Hill 2006, 114).

For the majority of citizens, life was a vegetarian one for much of the year, with meat provided by the city-state on festival days, and supplements from wealthy citizens when they wished to feed the common people, for certain political ends. “Euergetism” (benefaction) became rather more extensive in the Hellenistic period through public benefaction and the distribution of food by Hellenistic rulers (Chamoux 2003). Meat consumption was certainly lower for poorer citizens, since the price of meat was of necessity higher than that of fruits, vegetables, grains and pulses, because of the inefficient use of energy in raising animals and the cost of production. Richer people also ate more dairy products for the same reasons. Although meat was a symbol (Fiddes 1991), it was never a staple. The elite had access to meat of all kinds, but were still not heavy meat-eaters (Wilkins & Hill 2006, 57). Away from urban centres, however, farmers and wealthy absentee landowners consumed goat, mutton, pork and wild game more regularly, whereas urban dwellers probably consumed more fish than meat (Grivetti 2001).

Socioeconomic status also determined the quality of food eaten. Although the elite's diet was always more varied than that of the poor, cereals were the staple food for all social classes. Nevertheless, the rich were still able to signal their superiority over social and economic inferiors in their consumption of cereals. There was a hierarchy among cereal products, with white wheat bread at the top. Then came barley, lesser wheats, vetches and tares (Galen cited by Grant 2000). Wheat came in various guises, all of which were too expensive for the poorer classes who had millet and barley as staples. "Thus, the rich might afford white, wheat-based loaves; the poor, a black unleavened loaf of rye and barley or a maize-based porridge; and the very poorest, a practically indigestible chestnut bread" (Wilkins & Hill 2006, 16). Thus, proper white bread (*artos*) was baked in the form of round loaves and was not regularly consumed by the poor, who ate barley cakes or *maza*, sodden with water and eaten as porridge (Grivetti 2001, 8).

In conclusion, the well-off families had an advantage because they had access to a wider range of foodstuffs, to higher quality of cereals (i.e. wheat) and more importantly, to foods that were good protein sources, such as meat and dairy products. More importantly, they consumed more refined food items and they also cooked their food much more often than their poorer counterparts (Garnsey 1999).

2.2.2.1.2 The social status of women and children, and food distribution within the family

The social factors that result in sex-related health differences may vary according to the society that the population under study once represented. To give a context to this discussion of these social factors, some familiarity with the position of women in Greek society is needed. The Hellenistic Age was a period of large-scale political and social upheaval and in general, there was an erosion of the asymmetry between the sexes and a consequent improvement in the status of women, who started to gain economic and legal rights though not many political ones (Katz 1992). They could buy, own, and sell goods and property and will them to others (Wider 1986). Gradually the custom of allowing a woman to perform a public act (marriage or divorce, for example) only with the approval and representation of a man began to disappear in the Hellenistic world. Education became more common for girls, and women became involved in music, sports, and crafts. They were allowed more freedom of movement and more social interaction with men (Swidler 1976 cited by Wider 1986). We know a few instances of women being awarded honorary citizenship or even magistracies, owning land and slaves, being wealthy, even migrating. Increased opportunities for education contributed to the emergence of women poets, artists, and philosophers. Independence of action in public was a fact for some women who also apparently lived in households without men in some cases (Fantham *et al.* 1994). However, even if the masculine and feminine spheres may have been less sharply differentiated in the Hellenistic period compared with the

Classical, the gender gap had by no means been eradicated. Moreover, the extent to which these changes in women's social position affected everyday lives of women and men should not be exaggerated, especially as far as the lower socioeconomic (non-elite) classes are concerned, which also comprised the majority of a population (Blundell 1995, 200).

In Greek authors, a clear division of labour between men and women is usually taken for granted from as early as the Homeric age. Agriculture was considered the domain of the man, whereas the activities of women were confined to the domestic area. The picture drawn by our primary sources however, does not seem to refer to the actual living conditions of the majority of women of antiquity. Only a small fraction of all women would have been able to live such a well-sheltered life as that illustrated by the upper-class sources available to us (Scheidel 1995). Only men of some social and economic standing would have been able to keep their wives and daughters secluded in the house. That is because firstly, the mass of the population lived at or near subsistence level and secondly, a comparably large proportion of the labour force was employed in agriculture (Scheidel 1995). Because of the relatively low level of agricultural productivity and the high degree of local or regional self-sufficiency in the production of the basic foodstuffs, we may expect that even in urbanized areas, not fewer than two thirds of the population were engaged in agriculture (Scheidel 1995). Comparative material from other pre-modern societies suggests that it might be nearer to the truth to suggest an even higher figure of eighty or ninety percent of all people producing food or providing auxiliary services for the agrarian economy (Hopkins 1978). This alone should make it clear that ancient women will not as a rule have been barred from agricultural labour. At this point, two qualifying notes may be in order. This does not mean that women's work did not figure prominently in the domestic area; it is all too likely that many rural women spent most of their time caring for the children and for the sick, storing and preparing food, washing, processing wool, looking after poultry and their own garden plots. What needs to be stressed though, is the fact that a large number of women were possibly far from being exclusively confined to the domestic work chores but were also required to work outside their traditional province (Scheidel 1995).

Since the economic role of women profoundly affects their status and their personal freedom, the extent to which Greek women were involved in field work and other outdoor tasks is of considerable interest for any evaluation of their general position in the family and in society. Regardless of their actual contribution to the household economy, their participation in field work and the physical location of their daily work could likely have been a factor in shaping both their position within their own family and in the society (Scheidel 1995). Moreover, whether women took part in agricultural work is an important consideration also because there should be a link between the contribution of women to more readily acknowledged and respected economic activities such as rural work, as opposed to domestic work and child rearing, and the amount and quality of food and health care allocated to them. Active workers receive more food (Garnsey 1999). Thus, since women were possibly engaged in agricultural and, according to evidence (Wilkins 2000) suggesting that there were female bread-sellers and fishsellers in the market, also in other work, the gap between the sexes in the division of food should have been narrower than where women were confined to the home. However, this does not mean that the gap did not exist at all. Labour division was an indisputable fact. Furthermore, the lower social status of women was equally unquestionable. Therefore, if there was shortage of food resources, and someone had to go hungry, it would not have been the men, given that they make the bulk of the productive workforce. Women of child-bearing age might have been an exception as they should logically be categorised as "producers", in their role of social reproduction (Garnsey 1999). In addition, among the upper classes, women were probably more well-nourished (Pomeroy 1993); thus, the differences between males and females of the "elite", in terms of diet, were perhaps less pronounced.

Considering the fact that gender-differences were quite evident in Hellenistic society, another issue arises, and it is that of differential treatment of male and female infants and children (King *et al.* 2005). Goody (1982) states the general principle thus: 'While women feed young children irrespective of sex, they may not necessarily feed them equally, at least after they are weaned. In societies where preference is given to sons rather than daughters, women may themselves be the instruments of their own subordination'. In past populations, infection, as well as malnutrition, resulted in high morbidity and mortality of infants and children. Under marginal conditions, preferential treatment of male infants would have undoubtedly affected the most disadvantaged (Faerman & Smith 2008). For example, Scott and Duncan (1998) showed that infant mortality in England correlated with food shortages evidenced by fluctuations in wheat prices. Under such circumstances, gender differences in childcare and division of food may affect survival or, in less severe cases, result in stunted growth.

Favourable treatment of male infants/children might have manifested itself in three important ways: (a) better nutrition for male infants/children, (b) neglect of female infants/children by the denial of adequate care, and (c) preferential female infanticide (Pomeroy 1993). There are several factors underlying preference for male offspring in ancient Greece, such as the burden of providing dowries, the reliance on one's sons for support in old age, or the wish to ensure the continuation of the ancestral lineage through the male line. Moreover, older boys, along with men, made up the main part of the productive workforce (Garnsey 1999).

Consequently, both women and small, especially female, children were disadvantaged. Cultural values were a vital, controlling force and since we are dealing with patriarchal societies, adult males seem to have had an advantage in the division of food resources. Still, there may not have been gross inequality, especially if there was plenty of food to go round. The test would come if food was short, choices had to be made and restrictions imposed (Garnsey 1999).

Indeed, there is evidence to suggest that subadult and adult females and low socioeconomic status citizens were given a less generous share of the family food resources than males and high socioeconomic status citizens, respectively. Meat was always a high-status food because of the cost of production and was always acknowledged by the Greeks themselves as an indicator of wealth (Wilkins 2006). Richer people ate more meat and dairy products than their poorer counterparts. The Greeks marvelled at the wealthy Persians who cooked huge animals, such as camels and oxen, whole; the Homeric heroes feasted on beef; large-scale sacrifice was a feature of life in the ancient city-state. The major role played by animals is reflected in myth and religion where they contribute to a sense of identity and of belonging to a group (Wilkins & Hill 2006, x). The social structure of the ancient Greek world was, as previously mentioned, patriarchal and for this reason, men were likely to eat more animal protein than women. Studies on human remains also suggest this differentiation between the diets of males and females and low and high socioeconomic status groups, as expressed in the chemical deposits in the bones (Tzedakis & Martlew 2002).

2.2.2.2 Late 19th and 20th century Greece

2.2.2.2.1 Food consumption variations according to socioeconomic status

Available data for socioeconomic status differences in food consumption for late 19th and 20th century Greece are far more detailed than those for Hellenistic Greece. These data suggest that there was a pronounced dietary variation between urban and rural groups, and lower and upper classes, and that the contribution of certain foods to the dietary regimes increased with affluence.

More specifically, the amount of daily per capita available energy differed according to economic environment. For the 19th-century peasants in southern Greece, the available energy was estimated at 1926 kcal/day, while for the 20th-century herders, it amounted to 2310 kcal/day. For members of the urban working class, the per capita energy availability was 2336 kcal/day, for the middle class city inhabitants, 2903 kcal/day, and for the members of the 19th-century upper class, 3335 kcal/day. These differences can be partly attributed to differences in the mean age, to some extent, however, it is apparent that total energy availability increased with affluence (Matalas 2001, 40).

Among urban Greeks, the higher the degree of affluence, the lower the contribution of vegetable protein to energy availability. Carbohydrate accounted for 53.8%, 48.3% and 39.7% of total energy for working, middle and upper-class urban Greeks, respectively (Matalas 2001, 42). Energy from cereals represented about two thirds of the total available energy for the rural groups. The dietary importance of cereals, however, diminished with increasing affluence. Urban representatives of the working, middle, and upper class derived 60%, 48%, and 43% of their total food energy, respectively, from cereals (Matalas 2001, 42). Olive oil was available to the urban population in much higher quantities than to the rural population. Moreover, middle-class and prosperous urban unhabitants consumed butter on a regular basis, whereas this food item was not available to rural people (Matalas 2001, 42). Contribution of animal products to diet also varied according to economic environment and affluence. A remarkable difference emerges regarding consumption of meat; the per capita meat availability among southern peasants was, on the average, 30 g/day, whereas among working- and middle-class urban Greeks, it was 55 g/day and 77 g/day, respectively. Meat and eggs provided 4%, 6%, and 8% of the total available energy to peasants, working-class, and middle-class urban inhabitants, respectively. Sugar and honey were consumed by everyone. Their consumption was limited until the late 19th century, with the prosperous reaching 21 g/capita/day as opposed to only 10 g/capita/day for the poorer. Sugar availability greatly increased in the 20th century and reached 48 g/capita/day among representatives of the middle-class.

2.2.2.2.2 The social role of women, the preference of male children, and food allocation between the sexes

In late 19^{th} and 20^{th} century Greece, there are certainly signs of a gradual social transformation; women were seen to play more prominent roles in public life, especially during the last two decades of the 20th century (Clogg 2002). But most of them were still not educated housewives, secluded in their houses, and still in the process of fighting for equality between the sexes, especially in the late 19^{th} century and the first half of the 20^{th}. Women were still considered to be "inferior" to men and continued to spend most of their time in the house. The written records found in the modern cemetery confirm that 82.7% of adult women of known occupation were housewives (Eliopoulos 2006).

The role of women both in society and the family was largely determined by their participation in the labour market. Until the first half of the twentieth century, the family model of "complementary roles" was the predominant one, and most married women did not work, since professional employment was considered incompatible with the upbringing of children. "Complementary roles" exist when the activities of the husband and wife are different, but their functional interrelation makes them complementary. In this way, the percentage of women in professional employment showed a tendency to decrease from the beginning of the twentieth century up to 1960 (Maratou-Alipranti 2007). Over this period, the family was based on the strict separations of roles: the father plays the "instrumental role" and has responsibility for the survival of the family members, while the woman plays the "expressive roles" and has responsibility for the upbringing of the children, in this way ensuring the cohesion of the family unit (Parsons & Bales 1956).

After the 60s, however, very rapid economic growth in the countries of the west contributed to an expansion of the possibilities for women to participate in the labour market. Furthermore, the predominance of modern consumer models, aimed at increased spending and together with the tendency to maximize the prosperity of the household, had a positive effect on female employment (Maratou-Alipranti 1999). This development has led to a redefinition of gender roles in and out of the home, and to the prevalence of new family models. The number of "two-career" families, with non-differentiated marital roles is constantly on the increase, while the man's participation in the domestic sphere becomes increasingly crucial. As families where both spouses have employment outside the home have become the new model, the new prestigious female role is that of the working wife and mother (Maratou-Alipranti 1999). It should be also noted that salaried employment differentiates and reinforces women's position in the home, while at the same time it reduces their dependence on men. Apart from the developments in the labour market, a variety of other factors would also appear to contribute to the increase in the number of working women (Maratou-Alipranti 1999). The most important of these factors are the following: (a) technological changes, (b) increased social provisions from the state, (c) demographic developments and changes in women's life-cycle, (d) the return of the husband to the household and the couple's sharing of leisure time activities, (e) the gradual change in people's attitudes toward gender roles (Maratou-Alipranti 1999).

However, the fact that women continue to perform most of the household tasks, and that they still have to work a "double day", are indications that they are more bound to the household sphere, and that they are less dependent on their profession. The entrance of women into the Greek labour market had already begun to manifest itself at an increased rate in the 1970s. Despite this, Greek women registered the lowest employment rate when, in 2000, only 41.2% of the total labour force was female. According to the National Statistical Service records, women with the same jobs as men receive approximately 30% lower wages compared to their male colleagues.

The main difference in food distribution between the sexes in 20th century Greece, is observed in the consumption of meat. Meat symbolises social superiority, prestige, and aggressiveness. Men are those participating in the whole process of meat production, preparation and consumption. Vegetables, on the other hand, are considered a "female" food (Βαρδάκη 2001, 111). This food categorisation according to sex/gender, is based on the fact that women and men are involved in different stages of preparation and consumption, and this gives a symbolic meaning to food and, thus, shapes gender identity and roles. Women prepare (cook) and consume small quantities of meat, whereas men produce it, cut it up, and finally consume it in large quantities (Arvaniti *et al.* 2006). Every step of meat preparation and consumption influences the people involved in the process differently, both emotionally and psychologically. Thus, the role of men in food production and consumption is associated with feelings of manliness and bravery (Βαρδάκη 2001, 112).

In patriarchal cultures, such as Greece, where sex role stereotyping is pronounced, male infants are more favoured by the parents. Studies have indicated that male children in Greece are much more desired, welcomed, valued, and interacted with than female children (Vassiliou & Vassiliou 1970). This cultural preference often has differential attitude as a result and affects the parents' treatment of their infants from birth (Obermeyer & Cardenas 1997). It is, therefore, highly likely that this preference resulted in less favourable treatment of girls in nursing practices, parental care, and access to suitable food and medical resources (King *et al.* 2005, 556) also in the case of Greece. No direct evidence to support this notion was found in the literature, but this might well be attributed to this issue not receiving much attention by Greek researchers. However, there are a few studies that include indirect evidence, which indicate that parents' behaviour towards their female and male infants differs. For instance, according to a study on sex differences in rearing behaviour in contemporary Greece (Roe *et al.* 1985), the fact that Greek mothers use a more affectionate voice, when speaking to their infant sons than to their daughters, supports this notion.

2.2.3 Economy and diet

The economy and diet in Hellenistic and late 19th / 20th Greece are briefly discussed here, in order to provide an overall picture of the foods eaten and the extent to which each one of them contributed to the dietary regimen of the populations under study.

2.2.3.1 Hellenistic Greece and Thessaly

Hellenistic society in the eastern Mediterranean world was clearly divided into separate layers. At the top of the hierarchy came the royal family and the circle of the king's friends. The Greek and Macedonian elites of the major cities ranked next in social status (Martin 1996, 205). Closely following came the wealthy elites of the indigenous cities, the leaders of large minority urban populations, and the traditional lords and princes of indigenous groups maintaining their ancestral domains in more rural regions. Lowest of the free population were the masses of small merchants, crafts producers, and labourers. Slaves remained where they had always been, outside the bounds of society, although those who worked at court sometimes could live physically comfortable lives (Martin 1996, 206).

Agriculture remained the economic basis (Gallant 1989). Poor people performed the overwhelming bulk of the labour required to support the economies of the Hellenistic kingdoms. Many of the farmers worked on the huge agricultural estates belonging to the royal family, but city-states that retained their countrysides still had free peasants working small plots as well as larger farms belonging to wealthy landowners. Thessaly, in particular, was an exporter of grain and possibly a resource for other cities in Greece in peacetime, as it was in wartime to Roman armies (Garnsey *et al.* 1984). The level of technology was such that perhaps as many as 80% of all adult men and women, free as well as slave, had to work on the land to produce enough food to sustain the population (Martin 1996). In addition to arable land, peasants would use pasture, which was extensive in the mountainous areas, unsuitable for cultivation. The herds supplied milk, meat, and also leather and wool, which were essential material for various crafts (Reinders & Prummel 1998). In the cities, poor women and men could work as small merchants, peddlers, and artisans producing goods such as tools, pottery, clothing, and furniture (Martin 1996). Men could sign on as deck hands on the merchant ships that sailed the Mediterranean and Indian Oceans in pursuit of profits from trade. Wheat, primary materials such as wood and marble, metals like copper and tin, precious metals like silver and gold, cloths, ceramics, spices, and perfume were among the products traded (Chamoux 2003, 310).

Ancient literary sources, as well as archaeological evidence from human and plant remains, storage vessels, etc., indicate that the ancient Greek staple diet consisted of cereals, legumes, olive oil, and wine (Keenleyside 2008, 265). Cereal crops, most notably barley and wheat, comprised the main source of protein and carbohydrates (Rathbone 1983). Dry legumes, such as lentils, beans, and peas, were the most important source of protein for the larger part of the population, since meat and fish were not consumed regularly (Wilkins & Hill 2006). Cereals and pulses provided the majority of the body's energy requirements, as well as essential proteins, vitamins and minerals. Olive oil was the main source of dietary fat and wine mixed with water was the prefered beverage (Garnsey 1999). Oats and millet were grown mainly as a fodder crop for small farmers in times of food shortage (Garnsey 1988). Fresh and dried fruits, vegetables, nuts were also consumed, whereas honey, dates, and figs were the main sweeteners (Grmek 1989). Goat and sheep milk and cheese were also consumed but very rarely (Brothwell & Brothwell 1969; Grivetti 2001). Fish and meat were rarely eaten (Dalby 1996; Grivetti 2001). Meat, in particular, was highly valued and relatively scarce, and only occasionally accessible to the majority of the population (Garnsey 1999).

2.2.3.2 Late 19th and 20th century Greece

Greece had been a predominantly agricultural society until the 1970s. In the mid 1800s, the Greek State was limited to the southern part of its current lands and had a population of approximately one million (Matalas 2001). Peasants, small-scale farmers, and peasant labourers comprise about 90% of the active population. Farmers grew crops primarily for sustaining themselves and their families, and secondly for earning some income (Matalas 2001). Crops and products that the farmers were selling were mainly grapes, wine, honey, and, to a smaller degree, cereal crops. The core diet of the peasants in the late 19th century consisted of cereals, dry legumes, vegetables, wine, and fruits, and was supplemented with meat, seafood and salted fish, olive oil, olives, and cheese. Subsistence agriculture provided a great portion of the food consumed, in particular legumes, vegetables, cereals, wine, and some honey. Meat, eggs, and dairy products came from animals raised by the household (Matalas 2001). In most cases, olive oil, preserved fish, and cheese were purchased.

By the 1930s, the Greek population had increased to apporximately 6.4 million and 61% of the active population were peasants (Rihinos 1987). Besides the natural population growth, the expansion of sovereign territory that occured in the early 20th century and the influx of one million migrants from Asia Minor, contributed to the population growth noted (Matalas 2001). The dietary patterns of the Greeks in the early 20th century did not differ greatly from those that prevailed in the late 19th century. The diet was still based on cereals, legumes, vegetables, wine, and fruits, which, in rural areas, were produced by the household. Meat, salted fish, and cheese were consumed in small quantities by the poorer classes, whereas olive oil and olives were mainly consumed in the olive oil producing areas of the country (Dontas 1937 cited by Matalas 2001). Access to milk and dairy products, as well as consumption of meat, among the higher socioeconomic classes increased in early 20th century.

Food availability was at its highest during the periods that followed the harvest of cereal crops, i.e. during summer and autumn months, whereas in winter and spring months, available food decreased markedly. Some areas, such as the islands and mountainous regions, were particularly vulnerable to famine.

During periods of food scarcity, there were outbreaks of infectious diseases. Nevertheless, the phenomenon of famine was the exception, at least in the grain-producing areas. World War II though, and its aftermaths of occupation and consequent famine had a profound effect on the entire population of Greece. The countrywide famine of 1941-1942, in particular, killed and disabled large masses of the population, especially in the city of Athens (Valaoras 1946). In the 1930s, however, the majority of the population was chronically undernourished, basically due to a regimen that was deficient in high-quality protein (Ioakimoglou & Yianousis 1933 cited by Matalas 2001).

During the decades after World War II, Greek society completed its transition from a subsistence economy to a market economy. This economic and social transformation was accompanied by drastic changes in food availability and, consequently, in dietary patterns. Consumption of olive oil, for instance, significantly increased in all regions and social classes, with more marked changes observed among the lower socioeconomic groups and inhabitants of the non-olive-producing areas. Meat-protein consumption also increased. Cereals and breads, on the other hand, were consumed in smaller quantities. The diet during these decades, after World War II and before the invasion of fast-food culture, is characterised by the consumption of large quantities of whole grain bread, cooked foods and salads with vegetables and olive oil, moderate milk intake, high consumption of feta cheese and relatively rare consumption of meat for the majority of the population.

Towards the end of the 20th century, there is a decrease in cereal consumption, and a sharp increase in animal foods and vegetable oils and fats. On the other hand, the regular consumption of olive oil, fruits, and vegetables is maintained. The new dietary regime is also characterised by increased consumption of meat, especially red meat (beef) (Papoutsakis-Tsarouhas & Wolinsky 2001).

2.3 Hypotheses established

The important question is what effect all the above-discussed factors had on the distribution between populations, the sexes, and the socioeconomic status subgroups, of the diseases employed as health indicators in the present study. Although it is impossible to associate the impact of several of the biological factors, such as fluoride consumption (data not easily accessible in Greece) and genetic predisposition, on oral health, it is of great importance to consider the possible effect of the rest of those biological and social parameters and how these might have contributed to the oral pathology patterns observed. The influence of these determinants will form the basis for establishing the research hypotheses and provide the rationale behind them.

Firstly, a general hypothesis should be established. The basis of this hypothesis is that two populations, a pre-industrial and an industrial, which lived approximately 2000 years apart in completely different conditions (Table 2.1), are being compared. Climatic conditions have an effect on the health status of people; for instance, high temperatures and humidity regulate the distribution of insects, which transmit disease; natural catastrophes affect mortality rates; environmental pollution may be the major cause of the occurrence of various types of disease, and so on. Different geographical and geomorphological factors again affect subsistence economy due to food availability and hence diet and nutrition. Settlement patterns and population density also have an impact on the

Positive Factors / Economy		**Negative Factors**	
▪ **Oral hygiene**	Ancient < **Modern**	▪ **Population density / pathogen load**	Ancient < **Modern**
▪ **Medical treatment**	Ancient < **Modern**	▪ **Transmision of disease through animals / pathogen load**	**Ancient** > Modern
▪ **Fluoride consumption**	Ancient < **Modern**	▪ **Malnutrition / food shortages**	**Ancient** > Modern
▪ **Diet / higher protein consumption**	Ancient < **Modern**	▪ **Diet cariogenicity / Processed foods**	Ancient < **Modern**
▪ **Longevity**	Ancient < **Modern**	▪ **Air and water pollution**	Ancient < **Modern**
▪ **Economy (subsistence)**	Ancient = Modern (1st half of 20th cent.)	▪ **Social status of women**	Ancient = Modern
▪ **Economy (subsistence vs market)**	Ancient **vs** Modern (2nd half of 20th cent.)	▪ **Male infants / childern preference**	Ancient = Modern

Table 2.1: Differences and similarities between populations, and positive and negative factors affecting oral pathology

presence and prevalence of disease; increased population density for example, facilitates the spread of infections, respiratory diseases may be more prevalent in poorly ventilated houses and indoor pollution; cohabitation of humans and animals may also influence the presence of disease. Both the presence and frequency of disease are significantly affected by the availability of medical care, i.e. either treatment or prevention. Occupation and activity in general contribute to pathology and working conditions have an effect on both mortality and morbidity. Migration and introduction of new diseases, different genetic contribution, and cultural changes arising from that significantly affect the distribution and rates of pathologies. Technology and the level to which it has advanced in a society influences disease prevalence, either directly or indirectly; for instance, motovehicle accidents have caused lethal injury rates to increase significantly in present day populations, but advanced medical technology has given us the opportunity to prevent and heal diseases that were fatal in the past. Considering all the above (Table 2.1), it is realistic to assume that if there are differences between two populations in any part of human life, then they should have an impact on the health status of the population.

2.3.1 Comparisons between the Hellenistic and the modern population

The modern population is expected to exhibit higher overall frequencies of dental caries than the ancient population. Factors such as professional dental care, water fluoridation, personal oral hygiene and a diet more dependent on animal and fish protein would have acted to the advantage of the modern population. However, the heavy consumption of refined sugar and sugar/starch foods in modern populations is expected to have resulted in higher frequency rates. The demographic composition of the two populations would also contribute to the difference in the two populations, since in the modern population, the average lifespan is much higher than in the ancient and this difference is more pronounced in the female subgroup. Thus, there is a larger number of older individuals, regardless of sex, in the modern population and a large number of older female individuals too.

Therefore, and since (a) the longer teeth are exposed to a cariogenic environment the more chances there are for caries to develop, and (b) females tend to get more caries than males, the modern population is expected to show higher levels of carious lesions. It can be also assumed that the difference will be greater in the younger age group because ancient populations, whose diet did not include sugar, were not affected by caries in as young an age as in modern populations. Although the overall caries prevalence is expected to be significantly higher in the 20th century dental assemblage, the difference of root caries between population samples is expected to be much smaller. This is because pre-industrial populations are characterised by lesions that started in the cemento-enamel junction as roots were exposed by continuous eruption to compensate for heavy wear (Wasterlain *et al*. 2009). The archaeological assemblage should also exhibit more root than crown lesions, or, at least, relatively high rates of root in comparison to crown lesions. The modern population, on the other hand, should exhibit a significantly greater proportion of crown than root lesions.

Occlusal wear is also expected to be markedly heavier in the Demetrias assemblage due to the much softer modern diet. Periodontitis should have also affected the modern population more frequently and severely than the ancient. A higher mean age-at-death in the former population, would have contributed to this difference, since periodontal disease is age-associated (Grossi *et al.* 1995). Although oral hygiene practices and dental treatment are more advanced in industrial populations (Jain *et al.* 2009), a higher prevalence is expected for the modern sample in all age-groups, due to higher consumption of refined carbohydrates (Baumgartner *et al.* 2009), and poor immune response impaired by psychosocial stress, tobacco use, obesity, diabetes, and an unhealthy diet (Offenbacher *et al.* 2008). Antemortem tooth loss should also be more prevalent in the modern assemblage, for the reason that it is predominantly the result of dental caries and periodontal disease in both pre-industrial and industrial population (Lukacs 2007).

For dental enamel defects, it is difficult to establish a hypothesis. This is because the high frequency and severity of DDE may indicate greater exposure to malnutrition and disease (Wood 1996), or, alternatively, it could mean that the individuals with enamel defects managed to get through the disease and recovered, and thus there was time for the defects to develop (Arcini 1999; Wood *et al.* 2002). In order to determine whether the first or the second is the case, the association between developmental disruption and longevity will be explored in the *Discussion* (*Chapter 6*). Nevertheless, it is assumed that growth disruption levels will be greater in the archaeological assemblage, because of better nutrition, particularly higher protein consumption and maternal nutritional status, and advanced medical knoweledge and care in the modern population.

2.3.2 Comparison between the sexes

Comparing the sexes, the levels of caries are expected to be higher in the females of both populations for the following reasons: (a) the biological tendency of females to have a more cariogenic oral environment due to hormonal fluctuations (Lukacs & Largaespada 2006), (b) the higher consumption of meat by males (Garnsey 1999; Wilkins & Hill 2006), (c) women's proximity to food supplies and snacking during preparation (Lukacs & Largaespada 2006), (d) suppression of the immune system during pregnancy (Lukacs 2008), and (e) the earlier eruption of female teeth and their consequent exposure to caries for longer early on in life (Hillson 2006). It should be noted that the most decisive of these factors are the first two, for the reasons discussed earlier in this chapter. In contrast, the longer lifespan of males in the ancient population will possibly result in elevated overall carious lesion rates for males and higher frequencies than females in the older age group, since caries is an age-associated condition. However, the assumption is that females will exhibit higher caries prevalence in the first two age-groups. In most studies, females are also reported to display significantly higher rates of antemortem tooth loss than males (Jurmain 1990), and this is expected to be the case in both populations of the present study.

Periodontal disease is regularly reported to be more prevalent in males than females, regardless of social, behavioural and environmental factors (Albandar 2008). This is most likely the result of hormones, particularly the female hormone oestrogen, which protects against destructive periodontal bone loss (Genco 2000). Consequently, males should exhibit a higher prevalence of gingivitis and periodontitis in both populations, despite gender differences in social status. Occlusal wear is expected to be heavier in male individuals as males consumed a tougher and possibly more abrasive diet containing meat and fish, than females, both in ancient and 20th century Greece.

For dental enamel defects, it is again not easy to establish a hypothesis. Women are more buffered against the effects of the environment, as their immune response is more effective on average than that of males, and their prognosis for recovery is more favourable; males have a higher mortality rate in most countries in the first few weeks and months of life (Roberts *et al.* 1998). So, one may assume that women should exhibit lower rates of dental enamel defects. However, the absence of a lesion may indicate that the person did not suffer any infection, that the person suffered from an infection but recovered quickly (so that there was no time for the disease to leave a mark on the teeth or bones), or that the individual was too frail to resist the disease and died immediately or soon after (Wood *et al.* 1992). Therefore, the assumption that the female individuals should exhibit higher rates of enamel defects because most of them would have survived the infection when they were children, whereas more male children would have died immediately, could also apply. However, although there is a general tendency for males to be at greater risk of physiological disruption due to their genetic structure (Van Gerven *et al.* 1990) and also more vulnerable to enamel defects (Guatelli-Steinberg & Lukacs 1999), in the case of Demetrias in particular, social factors, namely preferential treatment of male infants/children might have resulted in greater levels of physiological disruption for females.

2.3.3 Comparisons between the socioeconomic groups

As has previously been mentioned, comparisons between socioeconomic status groups in the ancient population were based on the presence/absence of grave offerings; more specifically, remains from burials not containing grave goods represent the low socioeconomic group, whereas remains found in burials that contained grave goods represent the high socioeconomic status group. Thus, the individuals studied are distinguished into two broad socioeconomic status samples, based on the likelihood of some association between status in life and treatment in death.

There has been a long standing interest of anthropologists, bioarchaeologists, and archaeologists in the meaning and variability of mortuary behaviour which stems from the important links that are presumed to exist among forms of mortuary treatment, the ideology of death and concern for the deceased, and the structure of differential social status (Cannon 1989, 437). Robb and colleagues (2001) have suggested that there are three preconditions for establishing archaeologically a relationship between health, based upon skeletal/dental data, and socioeconomic status, based upon funerary treatment. The premises are the following: (a) the society in question was stratified into hierarchical social groups whose actual lifestyles differed significantly, in our case, in terms of diet/nutrition, general health, and growth disruption, (b) upper and lower class burials can be distinguished through archaeological evidence, such as grave goods, tomb construction, ritual treatment, and so forth, and (c) health and physical well-being in living people can be accurately distinguished archaeologically, through skeletal/dental health indicators (Robb *et al.* 2001, 115-116).

That the Hellenistic society was stratified into hierarchical social groups is indisputable (Chamoux 2003), therefore, the first precondition is free of complications in the case of Demetrias. The third premise, however, is complicated by several factors. Firstly, all skeletal and dental indicators "have particular conditions, stimuli, and thresholds for formation and remodelling, and they may form a mosaic of responses to complex biological situations more often than they form a coherent syndrome of skeletal stigma" (Robb *et al.* 2001). Another problem is the osteological paradox (Wood *et al.* 1992), which is particularly relevant to dental enamel defects. These two important considerations suggest a more careful interpretation of the disease patterns observed. A conclusion for the third premise, however, can only be drawn only after the results are presented, and will be taken under consideration in the *Discussion* and *Conclusions* (*Chapters 6* and *7*). Finally, whether grave offerings are a reliable social status indicator is open to discussion (Parker Pearson 1999). In some societies there seems to be an association between grave goods and socioeconomic status, whereas, in other societies, there is not, simply because the status in life and treatment in death can be mediated by many factors such as circumstances of death, the political situation, and the ideology of death (Cannon 1989; Robb *et al.* 2001; Ucko 1969). It is thus necessary to attempt a contextual reading of grave goods.

In the present study, the assumption was that there was no simple correspondence between presence/absence of grave goods and socioeconomic status and, consequently, no correspondence between socioeconomic status, defined by grave goods, and dental health status. The rationale behind this hypothesis is rather complex. Wealth and status are not absolute notions and cannot be strictly defined; in fact, there is no clear cut-off point between wealth and poverty, or high and low status. Thus, the high socioeconomic status group of the population might not strictly represent the "elite" of Hellenistic Demetrias and there should not necessarily be two broad social class (the poor and the elite), but rather, a more complex hierarchy and levels of social status. In fact, it is clearly known from literary sources that Hellenistic societies were characterised by a complex hierarchy (Martin 1996). Furthermore, the "division" of the burials into *low* and *high* socioeconomic status, was, to a certain extent, arbitrary, as it was based on the absence and presence of burial goods, respectively. Their presence/absence could have been a matter of individual choice rather than an expression of differential status and wealth (E. Nikolaou, *pers. comm.*, 16th September 2009). Thus, although a more intense mortuary response may perhaps reflect a greater social loss, proportional to the status and social role of the deceased, it may as well be an expression of a greater emotional loss and degree of personal sentiment.

In addition, there was no differentiation between female and male burials, in terms of proportions of burials with and without grave goods; half of the burials contained grave offerings and half of them did not, for both sexes. This also suggests that, in the case of Demetrias, social status in life is not reflected in treatment in death. Unfortunately, archaeological data on the exact content of the burials, the hierarchy of grave goods, tomb construction, and ritual treatment, are not available at present. Thus, reliance on the presence/absence of grave offerings and its association with socioeconomic status in life was considered too simplistic. As soon as more archaeological data is available though, a clearer picture will emerge. Nevertheless, the possibility of an association between presence/absence of burial goods and social status cannot be excluded; thus, dental evidence will be employed to show whether differences in funerary treatment may correlate with actual life conditions (Robb *et al.* 2001, 214).

If presence/absence of grave goods reflects socioeconomic status in life, then it is expected that dental caries will be higher in the low status individuals, due to the rarer consumption of meat, milk, dairy products and fish, and greater reliance on carbohydrates in comparison to high status individuals. The same should be the case for periodontal disease and, consequently, antemortem tooth loss. Occlusal wear should be heavier in members of the lower social group because they consumed less processed and often uncooked food items (Garnsey 1999), which require less powerful mastication and also little chewing time (Deter 2009). Physiological disruption should be greater in the low status group due worse living conditions, food shortages, malnutrition, greater exposure to infectious disease, (Rose *et al.* 1985; Littleton 2005) in the poorer classes.

In the modern population, the occupation of each individual at the time of his/her death is known from the public records held by the cemeteries in which they were buried, and it will be used as an indicator of socioeconomic status. The hypothesis that will be tested is that the individuals with occupations of higher status, such as lawyers and dentists, will be "healthier" than those with lower status occupations, such as labourers, builders, and so forth. More particularly, caries, periodontitis, antemortem tooth loss, wear, and enamel defects prevalence should be higher in the low status group due to a heavier reliance on cheaper foodstuffs, such as carbohydrates and lower consumption of meat, worse oral hygiene practices and limited access to (expensive) professional health care and treatment, worse living conditions, such as overcrowding, lack of protection from severe weather, and unsanitary conditions, higher exposure to pathogens, malnutrion, etc.

However, differences in oral pathology prevalence are not expected to be very pronounced, not because there was no class differentiation in 20th century Greece, but owing to the small sample size and the, potentially, poor reliability of occupation as a socioeconomic status indicator. The sample size is relatively small due to the fact that the vast majority of women were registered as "housewives" and, also because a large proportion of male individuals could not be assigned to either of the socioconomic status groups. Occupation is not considered to be a very reliable indicator (on its own), because, firstly, social class and wealth are not strictly defined by occupation, and secondly, there is not clear cut-off point between low and high class occupations.

Chapter 3

SITES AND MATERIALS

This chapter puts the materials under study into a context by briefly considering information on the topography, geography, geology and climate, as well as the history of the sites from which the assemblages were derived. Moreover, the archaeological background of the North Cemetery of Demetrias is discussed with regard to aspects relevant to the excavations of the site, the urban history of the town, the study of the cemetery, the chronological definition of the burials, and the mortuary evidence. Information on the acquisition of the skeletons comprising the modern assemblage and the creation of the Athens Collection is also included. Finally, this chapter also presents evidence relevant to the materials, namely, the reasons for selecting the specific burial assemblages, the criteria according to which individuals were included in or excluded from the study, the state of preservation, and the sex and age distribution of each cemetery population sample.

3.1 Demetrias

3.1.1 The Site

3.1.1.1 Topography, geography, geology and climate

Natural environment exerts a powerful influence on society through its indirect effects on economy, culture and social structure, all of which, subsequently, have an impact on the diet/nutrition, health and general well-being of its members. It is, therefore, important to briefly discuss the topography, geography, geology and climate of the area from which the cemetery population under study is derived.

Present-day Thessaly is one of the thirteen peripheries (regions) of Greece, and is further subdivided into four prefectures (*nomoi*), namely Larissa, Trikala, Karditsa and Magnesia. It lies in central Greece and borders Macedonia on the north, Epeiros on the west, Sterea Hellas on the south and the Aegean Sea on the east, and occupies the east side of the Pindos watershed, extending south of Macedonia to the Aegean Sea (Garnsey *et al.* 1984). Magnesia, deriving from the tribe name Magnetes, is name of the southeastern nomos of Thessaly. The capital of Magnesia prefecture is the metropolitan city of Volos, south of which the town of Demetrias was situated in the Hellenistic period (Fig. 3.1).

Figure 3.1: The geographical location of Demetrias

The plains of Thessaly are the second largest lowland in Greece, surpassed only by the plains of Macedonia and Thrace (Matley 1980 cited by Garnsey *et al.* 1984). The geology and topography of the area, however, is not homogeneous. Extending north to south along the eastern side is the administrative district (*nomos* in Greek) of Magnesia, which manifests much greater topographical diversity and is more mountainous than the other *nomoi* of Thessaly, with Ossa (1,978m) at the north, and Pelion (1,618m) to the south. The Khasia and Pindos mountain ranges and the Othrys plateau form the other boundaries of Thessaly (Philippson 1950 cited by Garnsey *et al.* 1984). This ring of mountains encloses two Tertiary crustal subsistence basins separated internally by a range of low hills. The western, or upper plain, is divided into two *nomoi*, namely, Trikala and Karditsa. The eastern, or lower plain, contains the *nomos* of Larissa. Each of the four *nomoi* comprising Thessaly has an average size of approximately 2,500 square kilometres (Garnsey *et al.* 1984). The base geological structure is composed mainly of unfoliated and foliated metamorphic formations, namely schists, gneiss and quartzite, with some outcrops of sedimentary deposits to the north (Garnsey *et al.* 1984).

Climate, hydrology and soils are the three most important environmental factors controlling potential agricultural productivity. The hydology of the western, or upper plain of Thessaly is quite complex. Numerous small, high-energy-flow streams pour out of the surrounding mountains on to the plain. The larger of these flow into the river Peneios, which is at the centre of this drainage network (Garnsey *et al.* 1984). In winter, very large quantities of water are brought down from the high rainfall zone of the Pindos mountain range, which, together with rainfall over the lowlands, accumulate in the low-lying areas; many of these areas are seasonally flooded or form permanent marshes (Garnsey *et al.* 1984). Periods of anaerobic conditions can lead to serious morphological damage of plants, and thus many lowland areas of the upper plain can be cultivated only with spring-sown crops or used as pasturage. The drainage pattern in the eastern, or lower plain, where Demetrias (Magnesia) was situated, differs, being a much more restricted riverine drainage system focused on the Peneios and its tributary, the Titarisios (Garnsey *et al.* 1984). Excess surface moisture is not as much of a problem on the lower plain, but periodic flooding of the Peneios has, in the past, presented considerable problems. The distribution of precipitation is heavier and less variable in the upper plain than in the lower, both annually and in the winter growing season. The upper plain has a more continental temperature regime and a much higher incidence of ground frost, especially in the surrounding hills (Garnsey *et al.* 1984).

The prefecture of Magnesia occupies the east side of Thessaly, encompassing a peninsula that ends in cape Trikeri, and encloses the Pagasitic Gulf in its embrace. The natural landscape of Magnesia consists of wooded mountains, cultivated flat land, and coastline (Karagiorgou 2001). One of its main elements is the Pelion mountain range, which is located in the eastern region of the prefecture and forms the eastern edge of the Pagasitic Gulf. Maurovouni mountain (1,054m) is the northeastly mountain of Magnesia and extends to the neighbouring prefecture of Larissa. The southwest border is Mount Othrys (1,726m) and forms the boundary with the prefecture of Phthiotis. The interior of Magnesia has two plains, the Almyros and the Volos-Velestino plain. The hydrological network of the area is not particularly rich and is characterised by the absence of large rivers, although smaller ones, e.g. Anavros and Xirias, do exist. The climate is temperate, the average temperature is 17 °C, and the average rainfall about 540 ml per year. Heat waves and intense long cold periods are not very common. Ancient Demetrias is situated along the coastline, on low hills, at a distance of 1,5 km south of the modern town of Volos, the capital of Magnesia, at the Pagasitic Gulf (Batziou-Efstathiou 2001). Two torrents, Xirias on the northern part, and Aligorema, on the southern part of the settlement, comprise the natural boundaries of the town. Its eastern limits follow the coastline, whereas the crest of the highest hill of the town, where the acropolis' wall was constructed, constitutes its western limits (Batziou-Efstathiou 2001).

3.1.1.2 The historical context

The death of Alexander the Great in 323 BC, was followed by continuous conflicts between his successors that lasted for decades (Chamoux 2003). In the beginning of the 3rd century BC, Demetrios Poliorketes (the Besieger), the son of Antigonos, one of Alexander's generals, rose to the throne of the kingdom of Macedon (Intzesiloglou 1996). He founded the Hellenistic town of Demetrias between 294 and 292 BC by merging many smaller towns of Magnesia, with the purpose of creating an economically and politically powerful town within a strategic site, as the old cities of Macedon were situated relatively far from the city-states of the south (Intzesiloglou 1996). Demetrias, which was destined to play a significant military and political role throughout Greece, was one of the largest and most important towns and harbours of the Macedonian kingdom and controlled the whole of the ancient Magnesia. Demetrios and his successors used Demetrias as a base for political interference and military attacks against Thessaly and Southern Greece (Batziou-Efstathiou 1996). The period of Demetrias' greatest prosperity was the third century BC. Archaeological evidence reveal a flourishing industrial and commercial city with a mixed population of Greeks from the southern parts of Greece and Macedonia, the Islands, and Sicily, and immigrants from Asia Minor, Egypt, Syria, and Phoenicia (Batziou-Efstathiou 1996; 2001).

As Roman intervention in Greek affairs became more energetic, this led to the loss of Macedonian rule in the area of Demetrias, after a decisive battle in 197 BC. Six years later, following a treaty in Corinth, Roman garrisons evacuated the city, which came under Macedonian rule once more, only to be surrendered again to the original inhabitants of the area, the Magnesians, in 167 BC (Batziou-Efstathiou 2001). The Magnesian fought as allies with the Romans, against king Mithridates, from 88 up until 63 BC, a decision that later led to the plundering of Demetrias by the navy of Mithridates (Batziou-Efstathiou 1996). The city started to decline from 1st century BC onwards and a large part of the town became deserted. Major state institutions survived up until the 3rd century AD, but the economic and transport functions of its great port gradually declined.

3.1.1.3 The archaeological background

3.1.1.3.1 The excavations and the archaeological site

Excavations conducted in the late 19th century have revealed that the site at which Demetrias is situated was first inhabited in the Neolithic period and inhabitation continued until the Hellenistic times, when Demetrias was founded. The excavations in the Hellenistic town of Demetrias commenced at the beginning of the 20th century, under the direction of A. S. Arvanitopoulos, who published the preliminary results of his research in the 1928 monograph "Γραπταί στήλαι Δημητριάδος-Παγασών" ("Painted stelae of Demetrias-Pagasai"). During this first phase of excavations, the walls and towers of the settlement, the sanctuary of Pasikrata, a large part of the south cemetery, the "Anaktoron" (palace), and the temple of Apollo were excavated. In 1961, D. R. Theochares started his research on the theatre and the "Anaktoron", which was later (between 1967 and 1981) excavated further by German archaeologists from the University of Heidelberg. In 1977, the 13th Ephorate of Prehistoric and

Classical Antiquities (ΙΓ' ΕΠΚΑ) undertook excavations at the site. The results of the rescue and systematic excavations have provided invaluable information on the organisation, the public and private architecture, and the urban history and development of the town, as well as on the way of life of its inhabitants. The North Cemetery of Demetrias (Appendix I, Illustration I.1), from which the osteological material studied for the purpose of the present work derives, was excavated by the 13^{th} Ephorate of Prehistoric and Classical Antiquities, at Volos, in the years 1995 and 1996, under the direction of E. Nikolaou. The excavations of the settlement are still in progress.

3.1.1.3.2 Urban history and development

The town constitutes one of the largest and most planned urban sites of Greek antiquity (Marzolff 1996). The urban development of Demetrias went through several phases. At the time of its foundation (Demetrias I), it appears as a huge fortified enclosure of 4,400,000m^2, including a mountainous citadel. During the lengthy and peaceful reign of Antigonos Gonatas (279-239 B.C.) this huge area was divided into two sectors (Demetrias II) (Marzolff 1996, 51). The western area included the fertile valley of Aligarorema and served as the first line of defence. The eastern area, with a perimeter of 8.25km, was more carefully fortified and shaped into a proper city. The main harbour of the city was constructed on the north side of the peninsula, after the river Aligarorema, which used to discharge itself there, was diverted to the south harbour, whose area was, by that time, silted up (Karagiorgou 2001, 64).

The Hellenistic city of Demetrias was built according to the Hippodamean system; insulae with overall dimensions 51x101m were divided into 14 or more building plots, of 350 m^2 each, and accommodated an estimated population of 25,000 people. During its Hellenistic heyday (217-168 B.C.), the city acquired most of its magnificent buildings: the Antigonid residence, the so-called 'Anaktoron', the Agora, with the temple of Artemis Iolkia, the theatre, the stadium or hippodrome to the north of the theatre, and the so-called 'Herôon', which was probably the mausoleum of the royal founder of the city, Demetrios Poliorketes. After the Roman victory at Pydna in 168 B.C. (Demetrias III), the city appears to have entered a period of decline, which was reversed during the Roman imperial and Late Antique years (Karagiorgou 2001, 65).

3.1.1.3.3 The study cemetery

The Hellenistic town of Demetrias has two organised cemeteries, situated outside the northern and southeastern part of the settlement's walls. However, since the population under study comes from the North Cemetery (Appendix I, Illustration I.1), the discussion that follows focuses on this particular cemetery.

<u>The chronological definition of the burials</u>

The North Cemetery of Demetrias comprised of burials dating to the Classical, Hellenistic and Roman times. Unfortunately, only the material dating to the Hellenistic period were included in the present study, as, due to the small number of Classical and Roman graves, comparisons among burials with different chronologies would not have produced reliable results. It should be noted that the chronological phases to which the study cemetery is attributed refer to relative chronology. Thus, the archaeological chronology was primarily based on the typology of artefacts, mainly pottery, found in association with the graves. In a significant number of cases, however, there are no grave goods associated with the burials and, consequently, no evidence for chronological definition. In such instances, stratigraphy and the association of the recovered burials with dated archaeological contexts (i.e. those containing grave goods) have been employed by the excavators to date the burials. Efforts have also been made to provide a narrower chronological framework, in order for comparisons among sub-periods of the Hellenistic to be feasible, but this is an attempt in progress. Hopefully, when this is completed, the issue of differences between the early and the late Hellenistic, that is, the time Demetrias flourished and the period of its decline, respectively, will be explored.

The mortuary evidence

The cemetery displays a variety of grave types, the majority of which are pit and tile graves, whereas shaft graves and some sarcophagi, marble urns and pot burials are also present. While inhumation is the commonest type of disposal, cremation was also practiced. The burials usually hold one individual only, but there are also graves that hold multiple burials, more specifically, between two and five individuals. The occurrence of multiple burials suggests that the remains probably belonged to members of the same family, and also implies that some of these are secondary burials. The inclusion of more than one individual in the same grave, however, does not occur very often.

The famous painted grave stelae discovered during the excavations of 1908-1920 are one of the most important archaeological findings of Demetrias. The themes of the paintings were inspired by everyday life and are usually related to the death or the life of the deceased; the themes include the farewell to the dead, a funeral feast, a woman giving birth, the embellishment of a woman by her servant, warriors, hunters, or, simply, a red ribbon, rossettes, and so on (Batziou-

Efstathiou 1996, 42). The name of the deceased is inscribed on the gravestone, whereas, in some cases, there are two names, a man's and a woman's. The inscriptions provide evidence that approximately 40% of the deceased were not natives of Demetrias but came from other parts of Greece, such as Crete, Epeiros, and Sterea Hellas, or were foreigners from Syria, Phoenicia, and Sicily, etc. During the Mithridatic war, at the beginning of the 1st century B.C., the towers at the east side of the acropolis were repaired and enlarged hastily, with the gravestones being used as building material, to fill in the space created between the old towers and their lengthening. This re-usage of the stelae had an advantage but a very negative aspect as well. The advantage is that the mudbricks covering them prevented the impact of humidity and lighting, thus creating favourable conditions for the maintenance of the colours of the paintings. The negative aspect is that the grave stelae can not be associated with the grave from which they were taken and, consequently, no association can be made between the gravestone and the deceased. An association of the gravestones with the deceased would have provided valuable information on, for instance, kinship, the descent and origin, occupation, social status, and sex of the individuals buried in the graves or, in some cases, even on the manner of death (e.g. during pregnancy).

It is interesting to note that the burial position is the same for all individuals, and that is the extended placement of the body with arms and hands most commonly placed on the side or, less often, folded in the abdomen region. Regarding the orientation of the deceased, there is no standardisation; the general tendency is for the burials to be placed with the head to the east, and, less often to the west, north, south, north-east, and south-east. It should also be noted that available evidence does not indicate the development of clustering within the cemetery.

Interestingly, there is an evident differentiation with regard to the presence, variability and quantity of burial assemblages. Three categories can be easily distinguished: (a) graves without any artefacts, (b) graves moderately furnished with grave goods, and (c) graves containing a larger quantity and/or variety of artefacts, and/or imported items, and/or items made of precious metals, such as bronze, silver, or gold. The moderately furnished graves contain unguentaria and oil lamps, whereas grave goods in "richer" burials range from lekanae, dishes, kantharoi, figurines, clay or bronze pyxides with siren-shaped legs sculpted in relief, oinochoes, lead pyxides, skyphoi with relief decoration, to coins and jewellery. The distinction between the moderately furnished and richer burials, however, has not been made, because relevant archaeological data, that is the exact content of each grave, is not available at present. As a result, the second and the third category, i.e. graves containing grave goods, were considered a single category and were compared to graves without burial goods. In order to test the hypotheses regarding the correlation between social status and dental health, it was assumed that the individuals buried in the former were of higher socioeconomic status than the individuals buried in the latter. The question as to whether the treatment in death and particularly the presence/absence of grave goods is associated with social status in life is discussed in the *Hypotheses Chapter*.

<u>The study of the cemetery</u>

The study of the cemetery, in terms of chronology, mortuary practices, and grave goods started immediately after the excavations commenced, in 1995, and is still a work in process of completion. Not much of this work has yet been published, other than in the *Αρχαιολογικόν Δελτίον*, mostly in the form of excavation reports. Additionally, some of the findings have been presented in conferences. Regarding human remains, this is the first study to be carried out on the North Cemetery population of Demetrias. The ultimate aim is to combine mortuary and bioarchaeological evidence, and, when the study of the cemetery is completed, to publish the results of the studies in a monograph and in relevant scientific journals.

3.1.2 The material

3.1.2 Period, site and collection selection

The period, site and collection were selected in view of the hypotheses; however, at the same time, the testing of the hypotheses depended on the material available and their establishment was determined by the potentiality of the assemblages. The initial aim was to (a) explore the issues of how socioeconomic status differences affect health, (b) determine whether treatment in death, and more specifically, grave goods, reflect social status in life, and (c) examine how gender differences influence disease prevalence and patterns. The modern population, however, provided the opportunity to focus on how different health and disease patterns were in the past, without having to rely on studies on living populations for comparative purposes. Thus, the general hypothesis to be tested was that variations in socioeconomic conditions result in differences in the general well-being and dental health of populations (i.e. ancient versus modern) and sub-populations (e.g. females, low socioeconomic groups) with significantly different environmental and socioeconomic backgrounds.

In order to comprehend better and interpret results derived by study of the Hellenistic population, comparisons with material from other time-period(s) and diverse socioeconomic circumstances, from the same geographical region or from the site of Demetrias would have been very helpful. Unfortunately, Classical and Roman remains yielded a very small number (n=13 and n=14 individuals, respectively) in Demetrias and were thus not suitable. Alternatively, Hellenistic assemblages from other parts of Greece could have been utilized for comparative purposes but, at the time, all available remains constituted small samples, which were biased towards a highly selected part of the society they represented. Moreover, published analyses of Hellenistic human populations are very few in Greece, and even those that could have served as comparative studies have employed a completely different methodology and/or they do not provide data for sex and age groups (mostly, as a result of poor preservation) (e.g. Fox 2003); thus, they were not regarded as being comparable. It was, instead, considered appropriate that all material included in the present analysis were studied by the author in order to provide methodological standardisation, which benefits comparisons and produces more reliable results.

The modern collection, which comprises the only modern human skeletal population in Greece, was available when this research started and its comparison to the Hellenistic population was seen as an exceptional opportunity to test the hypothesis that variation in the environmental and socioeconomic conditions should be evident in oral pathology prevalence, severity and distribution pattern. Thus, the modern population was studied for comparative purposes, whereas exploring the issues mentioned in the first paragraph of this section, i.e. how social inequality manifests itself in population health, whether treatment in death is associated with social status in life, and how gender differences influence disease patterns, continued being the main aim of this research. To summarise all the above, the study of the two populations provided the opportunity to meet the main objectives of this work, which focused on (a) the Hellenistic population with comparisons among groups with different socioeconomic status, and (b) the differences and similarities between past and present (pre-industrial and 20th century industrial) health patterns with comparisons between the ancient and the modern population.

The period selection depended upon several factors. The most important of them was that the Hellenistic period in Greece has not been extensively studied by archaeologists and biorchaeologists/anthropologists. It is a historical period and therefore literary sources are available, but the main focus, in terms of archaeological and osteological studies, has been on the Classical and prehistoric periods, especially the Bronze Age. Such studies are even scarcer for Thessaly and Magnesia in particular. Moreover, the present work comprises the first analysis of Hellenistic human remains in Demetrias, and possibly, the most extensive (in terms of sample size) and systematic one, on Hellenistic material, in Greece. The fact that the Hellenistic is a historical period is also one of the selection factors, since more data is available regarding the historical events and socioeconomic conditions of the time. Furthermore, the Hellenistic was the most representative period in terms of sample size in Demetrias.

The decisive factor for selecting the specific site was the significance of the region in Hellenistic times and the fact that little is known about it. Demetrias was an ecomomically prosperous trading centre, as well as a politically and strategically powerful town, for which a relatively small number of studies has been carried out so far (relevant bibliography in: Kontaxi 1996; Batziou-Efstathiou 2001). Its importance is attested by the fact that it was the second capital of the Macedonian kingdom after Pella, and served as a naval harbour for the Antigonids, one of the dynasties of Hellenistic kings that descended from Alexander the Great's general Antigonos I Monophthalmos and controlled the old kingdom of Macedon, as well as most of the Greek city-states, at the time of Demetrias' prosperity (Reinders 2003). Furthermore, the studies on Demetrias focus on the architecture of its buildings and the town's urban planning (Kontaxi 1996), whereas nothing is known about its people, since no research has been conducted on the osteological material from the excavated cemeteries (E. Nikolaou, *pers. comm.*, 16th September 2009).

The particular human skeletal assemblage selected for this thesis provided numerous advantages in terms of preservation and sample size, as well as availability and accessibility of excavation/archaeological records, although at a preliminary level, contextual information and mortuary evidence. The state of preservation and completeness of the skeletal remains was one of the most important criteria for the selection of the particular assemblage; this is because preservation and completeness largely determines sex determination, age estimation and data recording, and consequently, the aims of the study. The soil constitution of Greece does not favour good bone preservation (Nafplioti 2007); thus, large well-preserved skeletal assemblages are quite rare in this part of the Mediterranean. In addition to taphonomic processes, excavation, recovery, curation and storage have a significant impact on what is finally left to be studied. The majority of archaeologists in Greece do not have a knowledge of the procedures of collection, conservation and analysis of human remains. This fact, as well as the lack of appreciation of the full potential of osteological research, has even led to the discarding of large well-preserved populations (Triantafyllou 2001) or to retaining skulls only and discarding everything else (Fox 2005). The population of the North Cemetery of Demetrias, thus, comprises one of the few large well-preserved human skeletal assemblages comprising of articulated skeletons from, mainly, individual burials, and also one of the rare cases of a large, and hence more representative, assemblage dating to a single time-period in Greece. Its state of preservation is very good, partly due to the burial environment but also owing to the very careful excavation and collection of the skeletons by experienced archaeologists. More information on preservation and completeness is provided below (3.1.2.3.).

Moreover, the material under study offered the opportunity to study the human skeletal remains in their burial context and combine biological and mortuary evidence. The enormous potential of archaeologically establishing a relationship between health, based upon skeletal data, and status, based upon funerary treatment is not always feasible for several reasons. For instance, elite and commoner burial in many cases cannot be distinguished through archaeological evidence such as grave goods, tomb construction and ritual treament, or, the burial sample does not present a representative cross section of the society, that is, it does not represent all parts of the social spectrum (Robb *et al.* 2001). Furthermore, in many excavations, the remains recovered are commingled and, thus, individuals cannot be associated with specific graves, whereas in others, detailed excavation records are not available or accessible. In the case of the North Cemetery of Demetrias, articulated remains, individual burials, the very detailed reports of the content of each grave, the tomb type, the orientation of the deceased, and other contextual information, and the well-defined chronological framework allowed for health patterns to be considered within a social and historical context. At the time the present research commenced, the intention was to utilize all mortuary evidence; unfortunately, due to time limitations, the study of the cemetery by the excavator has not been completed yet and, therefore, this was not possible. It was, however, possible to use grave goods as indicators of socioeconomic status. Further study of the cemetery, in combination with biological evidence, will, hopefully in the near future, reveal a clearer picture of the society and people of Hellenistic Demetrias.

3.1.2.2 Inclusion criteria

The skeletal material under study comes from the 924 graves of the North Cemetery of Demetrias, which were excavated in the years 1995 and 1996, by the 13th Ephorate of Classical and Prehistoric Antiquities of Volos, under the direction of E. Nikolaou. Unfortunately, a quite large proportion of the burials did not meet the conditions in order for them to be included in the study. For instance, although the excavators were very cautious and the excavation and recovery of the remains were well-organised and very carefully conducted, some of the skulls and mandibles had been accidentaly separated from the postcranial skeleton (possibly during their transfer from the cemetery to the storage area) and did not have a tag/label with the burial number on them. Moreover, some of the graves contained either no remains at all, or, extremely poorly preserved remains that were not even recovered by the excavators. Additionally, for the purposes of this study, it was felt appropriate to limit the sampling to (a) burials from a discrete and more homogeneous period, the Hellenistic, for reasons previously stated, and to (b) sexable and ageable adults. The sex and age of the individuals were considered to be of vital importance because, in this way, bias in pathology prevalence and severity due to sex- and age-related factors is avoided; therefore, skeletons of undetermined sex and age were excluded.

Hence, of the individuals buried in the 924 graves excavated, 300 were those that fulfilled the criteria and were, therefore, included in the present study. In summary, the criteria were the following: (a) a minimum age 20 years (adult), (b) good preservation, (c) presence of teeth, alveolar bone, and intereseptal areas, (d) feasibility of sex determination, (e) feasibility of age estimation (an exception was made for nine individuals that could not aged but were still included because they fulfilled the rest of the criteria), (f) availablility of chronology, (g) chronological framework (Hellenistic period), (h) assignement to a particular context (grave), and (i) availability of mortuary evidence. Thus, the sample analyzed comprised all available sexed and aged adult individuals with teeth, and/or alveolar bone and interseptal areas from burials that date to the Hellenistic period, and for which, mortuary evidence is available.

3.1.2.3 Preservation of the material

Fortunately, the material has been free from severe disturbance, which would have caused the disarticulation of the skeletons. Thus, the assemblage comprised articulated skeletons only. Bone preservation ranged from poor to excellent, but, overall, the skeletons were very well-preserved, especially when compared to archaeological material from other parts of the country, which are often very badly preserved, mainly due to the acidic soil environment. Apart from the taphonomic processes that took place during the bones' burial for more than 2,000 years, preservation of the remains was also affected by machine diggers prior to excavation, recovery by non-specialists, post-excavation handling, transport, and humidity and unstable temperatures in the storage area; all these have resulted in bone fragmentation, and some, fortunately not extensive, mixing of contexts. Due to this deterioration and mixing of contexts, some of the skeletons and/or teeth had to be excluded from the analysis. It should be noted that the state of preservation discussed in this section refers to the individuals included in the present study rather than the whole assemblage from the North Cemetery of Demetrias.

All skeletal elements were represented, including ear ossicles, which were present in a considerable number of cases. A large number of skulls and pelves were in an excellent condition; additionally, a large proportion of the maxillae, mandibles, tooth sockets and interseptal areas were complete and most teeth, when present, were found in occlusion. Thus, sex determination and age estimation was in most cases reliable and oral pathology and dental attrition were recorded in a large and representative sample of teeth. Most bones, when present, were not eroded or very fragmented, and tooth enamel was not severely affected. Overall, the majority of surviving bones, especially maxillae, mandibles, as well as teeth included in the study were complete, whereas some of them were fragmentary. There are no instances of an individual represented by one skeletal element only, whereas, in the vast majority of cases, at least 15-20% of the skeleton was present.

In summary, 57.7% (n=173) of the skeletons was in a poor state of preservation (<25% present), 33.3% (n=100) was partial (25-75% present), whereas 9.0% (n=27) was complete (>75% present). Analysis by sex group revealed a better representation of male skeletal material, meaning that remains of male individuals were better preserved, less eroded and had a higher degree of completeness than those of female individuals. More specifically, 51.7% of the male skeletons was poorly preserved, 37.9% was partial and 10.3% was complete, whereas the preservation of 65.9%, 27.0% and 7.1% of female skeletons was poor, partial and complete, respectively.

3.1.2.4 Sex and age composition of the population

The present research was conducted on the remains of 300 articulated adult individuals, i.e. relatively complete skeletons, selected from the material coming from the 924 graves of the North Cemetery of Demetrias. The term “complete skeletons” denotes remains that come from burials containing skeletons readily identified as individuals, even if, in some cases, more than one set of remains has been placed in the same grave (Buikstra and Ubelaker 1994, 5). It is also worth noting that only adult individuals comprised the sample studied, since a very small number of subadult individuals (n=5) was recovered during the excavations; the sample was considered unrepresentative and, therefore, unsuitable for the purposes of the present study. The low representation of subadults may be partly associated with recovery, preservation and conservation bias, but it should be also largely attributed to different funerary practices for infants and children, who were seemingly buried outside the cemetery (Golden 1988).

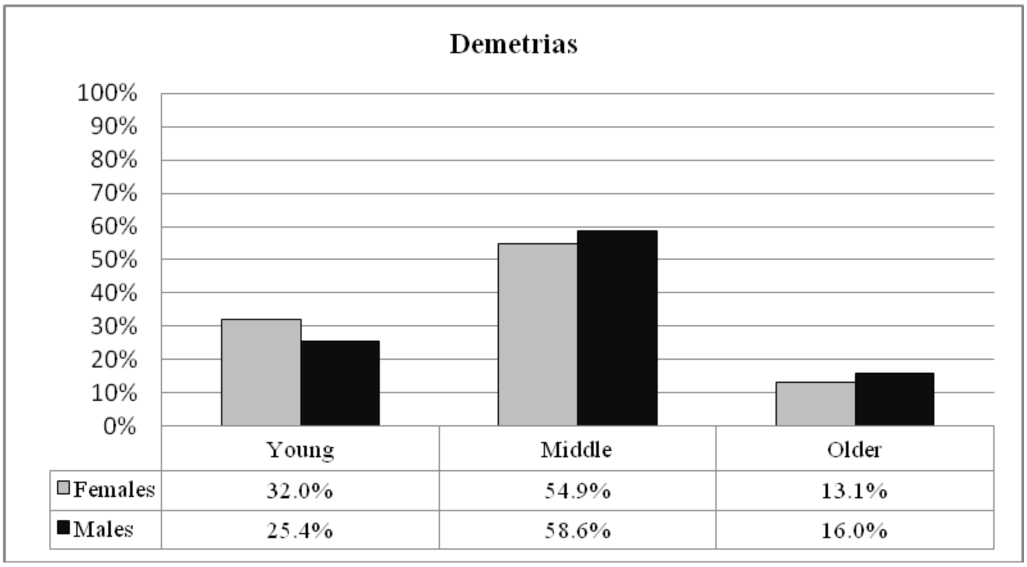

Figure 3.2: Sex and age composition of the Demetrias population sample

In brief, of the 300 adult individuals of the population sample included in the present research, 126 (42.0%) were females and 174 (58.0%) were males. Eighty-two (28.2%) of the individuals, regardless of sex, were young (20-35 years), 166 (57.0%) were middle (35-50 years) and 43 (14.8%) were older adults (50+ years). Out of 122 female individuals, 39 (32.0%) were young, 67 (54.9%) were middle and 16 (13.1%) were older adults; of the 169 male individuals, 43 (25.4%) were young, 99 (58.6%) were middle and 27 (16.0%) were older adults (Fig. 3.2). Thus, comparisons between the sexes revealed that a larger proportion of female individuals died between the ages of 20 and 35 years and a lower percentage of females lived after the age of 50 years. A higher risk of dying young and a shorter lifespan for females were typical in pre-industrial societies and they are attributable to reproduction, that is death during childbirth and reproductively-related wear and tear on women (Doblhammer 2000).

3.2 Athens

3.2.1 The Site

3.2.1. Topography, geography, geology and climate

As it is the case with the population sample from Demetrias, the life of the inhabitants of Athens was strongly influenced by the surrounding physical environment. Therefore, it is important to mention a number of key features of the topography, geography, geology and the climate of the area from which the cemetery population under study is derived.

Present-day Attica (Attike), which covers about 3,808 square kilometers, is one of the thirteen peripheries of Greece and is futher subdivided into the prefectures of Athens, Peiraias, East Attica and West Attica. It is located in the southern part of Greece and borders the periphery of Central Greece on the north west, the Peloponesse on the west, and the Aegean Sea on the east and south. More specifically, the peninsula of Attica borders with the prefecture (*nomos*) of Boeotia on the north-west and with the prefecture of Corinth on the west; her eastern shores face the Aegean Sea, her north east shores Libya, and her south west shores the Saronic Gulf (National Statistical Service of Greece 2003).

The city of Athens is the capital of the periphery of Attica and Greece. It lies in a plain at the central part of Attica, a bit to the south and approximately 7 km away from the nearest coastline (Fig. 3.3). This plain is contained by the mountains of Parnitha (1,413m) at the north, Penteli (1,109m) at the east, Ymmetos (1,026m) at the south east, and Aigaleo (453m) at the north west. The south west side of the plain faces the waters of the Saronic Gulf. There are two more plains, i.e. the Mesogeia on the south east, and the Thriassio to the west (National Statistical Service of Greece 2003).

Figure 3.3: The geographical location of Athens

Attica is relatively dry compared to northern Greece, with particularly shallow soils on the hills and mountains. The climate of Athens belongs to the Subtropical Mediterranean (semi-arid) type, with extremely long periods of sunshine and a low average annual rainfall (Stamatis *et al.* 2006). The greatest amounts of precipitation occur between mid-October and mid-April, usually as short, heavy showers or thunderstorms. Summers are very hot and heatwaves are common during July and August when temperature rise to 40°C. Winters are mild and snowfalls are not common, although frost may occur (Stamatis *et al.* 2006).

The soil in the area is generally poor. It is unsuited to stockbreeding and to agriculture, except for olives, vines, and figs. The territory is, however, rich in limestone and marble in the mounts of Penteli and Ymettos, silver and lead in the hills of Lavrion, and in clay deposits at the northern suburb of Amarousi and Ayios Kosmas (Higgins & Higgins 1996). The geological structure of Attica, as in much of Greece, is dominated by a series of nappes stacked up during Alpine compressional movements (Higgins & Higgins 1996). Its mountains are dominantly made of Triassic limestones of the Pelagonian Zone similar to those occurring as far north as Thessaly and western Macedonia, whereas the southern and eastern parts of Attica are underlain by schists and marbles (Higgins & Higgins 1996).

3.2.1.2 The historical context

After centuries of Ottoman rule (1453-1832), the first Greek state was established. The last two decades of the 19th century saw Greece trying to set the foundations of a modern state through a series of public works that would also lead to economic growth. Unfortunately, the declaration of bankruptcy in 1893, and the military defeat in the war against the Ottoman Empire in 1897 led to poor morale and economic prospects. This caused a wave of emigration during the late 19th and early 20th century. It should also be noted that a large number of Greek populations were still living under Ottoman rule (some until 1947), outside the borders of the newly-found Greek state, which was less than a century old (Clogg 2002).

Remarkably, Greece before, during and shortly after World War I was to emerge as the up-and-coming power in the Eastern Mediterranean, increasing her territory after a series of wars against the Turks at first, and later on, against the Bulgarians. By 1913, Greece had added almost 70% to the land area of the "Old Greece". A further expansion towards Asia Minor in 1919, in order to protect the local Greek populations, eventually led to the catastrophic events of 1922; the Greek army evacuated Asia Minor, followed by an unprecedented wave of refugees fleeing towards the islands of the Aegean and mainland Greece. Those refugees counted hundred of thousands and their arrival in Greece, especially in Athens, where many of them settled, radically influenced local communities (Clogg 2002).

Up until World War II, the political and social life in Greece remained unstable. Greece entered the war on the side of Allies, but, after the war ended, it went through a civil war that dragged on up until 1949. During the 50s and the 60s, Greek governments aimed to support economic growth, with the purpose of counter the bad state of Greek economy. However, they could not prevent a new wave of emigration towards Germany, North America and Australia in particular. A dictatorship was imposed from 1967 until 1974, when a crisis in

Cyprus and an invasion by the Turkish army led to the surrender of power from the military to the politicians. In the late 70s, Greece became a member of the European Union. During the 80s and the 90s, relations between Greece and Turkey remained uneasy (Clogg 2002).

Athens, as the capital of Greece since 1834, was the centre of political, economic and cultural developments. It experienced a major growth of urbanization, especially in the second half of the 20th century, the decades after World War II (from the 50's until now), and also witnessed an acceleration of contact of all kinds with other European countries in areas such as trade, travel, diplomacy and exchange of ideas. In the second half of the century, there were also signs of gradual social transformation. Women, for instance are seen to play more prominent roles in public life and popular participation in government increased, especially towards the last decades (from the beginning of the 80s) (Clogg 2002).

3.2.1.3 Modern Greek funerary customs and specimen acquisition

In present day Greece, the deceased are exhumed three to five years after their burial and their bones are placed into boxes where they remain until the family of the deceased decide they no longer want them in the ossuary. The bones are thereafter disposed of in large pits within the cemetery. The tradition of exhumation is universal in the country and there are two explanations as to how it became part of the funerary customs. According to the "spiritual" explanation, it is the result of visions, which some people claimed to have had, of a deceased saint that instructed them to exhume their remains, as these possessed healing and other powers (Eliopoulos 2006, 41). The second explanation is related to the lack of burial space; although exhumations first took space in monasteries, the practice spread to rural areas and large cities in particular, where burial space is very limited (Eliopoulos 2006, 41).

The funerary practice of exhumation, therefore, provides a unique opportunity for research, as it produces a large number of skeletons that can be collected before their disposal in the large underground pits. The skeletons of the modern population studied for the purposes of the present research were obtained before this last stage of their disposal into the pit, while they were still in the ossuary. The first part of the collection was created by A. Lagia, at the Wiener Laboratory of the American School at Athens, between the years 1996 and 1997. This collection was named "Wiener Lab Collection" (Pike 1997 cited by Eliopoulos *et al.* 2007) and consists of 72 skeletons that come from cemeteries in the city of Athens. In 1998, the collection was donated to the Department of Animal and Human Physiology, University of Athens (Roberts et al. 2005 cited by Eliopoulos *et al.* 2007), and it was housed at the Laboratory of Biological Anthropology. Between the years 2001 and 2003, C. Eliopoulos obtained and prepared an additional 153 skeletons, bringing the total number of specimens in the collection to 225 (Eliopoulos 2006; Eliopoulos *et al.* 2007, 222). These two parts of the assemblage comprise the modern human skeletal collection known as "the University of Athens Human Skeletal Reference Collection or, in short, "the Athens Collection" (Eliopoulos *et al.* 2007, 222).

After the necessary legal paperwork addressed to the directors of several cemeteries was submitted to the municipalities requesting the human remains, the skeletons were donated to the Wiener Laboratory, initially, and the University of Athens (Eliopoulos 2006, 46). Two of the cemeteries agreed to donate the remains, exclusively for research purposes, instead of disposing them into the underground pits (Eliopoulos *et al.* 2007, 222). One of them was the Zografou Cemetery, which is close to city-centre of the capital and serves the municipalities of Zografou and Athens, and has, approximately, 15,000 graves. The second one is the Third Cemetery of Athens, which serves the municipalities of Athens, Nikaia and Korydalos, and has 30,000 graves. After meetings with the directors of the cemeteries, where all the details regarding procedures and research purposes were explained, permission for the collection of the skeletons was granted (Eliopoulos 2006, 46).

3.2.1.4 Creation of the collection

The next step, after the permission was granted, was the selection of the specimens at the ossuary. The prerequisites for this selection were the presence of the "exhumation card" within the box, which contained the name of the individual, the number of the grave and the date of the exhumation, and the good state of preservation of the remains (Eliopoulos 2006, 47). After that, the death certificates of the deceased were traced in order for the information on the sex, age at death, occupation, cause of death and place of birth to be collected (Eliopoulos *et al.* 2007, 222). Whereas the initial collection of skeletons was random in terms of sex and age, towards the last part of the selection procedure, it was decided to include remains of individuals from the age and sex categories of inadequate representation; more specifically, younger ages from 20 to 40 years and especially females were selected (Eliopoulos 2006, 47). A balanced skeletal assemblage in terms of age and sex representation is quite useful when the assemblage is used as a reference collection, but it has a negative effect on studies with a bioarchaeological approach, since it maximises demographic bias (Eliopoulos 2006, 47-48).

For the cleaning of the remains, which were skeletonised with a small amount of soft tissue present, it was decided to use the method of boiling, as it is considered to be the most effective for fat and soft tissue removal and, at the same time, the least destructive for bone (Fenton *et al.* 2003; Nawrocki 1997; Stephens 1979 cited by Eliopoulos *et al.* 2007). After boiling, each skeleton was given a unique reference number, which, after the bones were dried in open air conditions, was written with a permanent marker on each skeletal element (Eliopoulos *et al.* 2007, 223).

3.2.2 The material

3.2.2.1 Period, site and collection selection

The rationale for the period and collection selection has been discussed in 3.1.2.1; it has, also, already been pointed out that the modern material was used for comparative purposes and provided an exceptional opportunity to test hypotheses regarding the effect of environmental and socioeconomic conditions on health. The modern collection selection was also based on the excellent preservation of the skeletons, the adequate amount of individuals, the availability of written records, and its comparability with the archaeological population. Regarding the latter point, it is important to note that, although the skeletal collections come from two different geographical locations, with a long chronological distance between them, they have many similarities, which make them comparable. They are both populations living in economically and politically powerful urban centres, flourishing industrial and commercial cities, close to the sea (large harbours), with a mixed population of Greeks from mainland Greece and the islands and immigrants from Asia Minor and Egypt. The climatic conditions and geographical setting are also very similar.

3.2.2.2 Inclusion criteria

Of the 225 skeletons that comprised the Athens collection, 207 were those that fulfilled certain criteria, and were, accordingly, included in the present research. The criteria were as follows: (a) a minimum age of 20 years (adult), (b) good preservation, (c) presence of teeth, and/or alveolar bone, and intereseptal areas, (d) feasibility of sex determination, and (e) feasibility of age estimation (one exception of a skeleton that could not be aged was made). More specifically, of the 18 individuals that were excluded from the study, 16 were subadults and 2 were not well-preserved. Thus, the sample analyzed comprised all available sexed and aged adult individuals with teeth, and/or alveolar bone and interseptal areas.

3.2.2.3 Preservation of the material

During the preparation of the specimens, observations regarding their preservation and condition revealed that all the skeletons were complete with only small elements missing, such as hand and foot bones, and that almost all the bones present were in an excellent condition (Eliopoulos 2006, 61; Eliopoulos *et al.* 2007, 223). Of the 207 skeletons that fulfilled the criteria and were included in the present research, 205 (99.0%) were complete (>75%), whereas only 2 (1.0%), both of them female, were in a poor state of preservation (<25%).

The most common defect observed on the bone elements was erosion but this was observed in a few cases only and was minor. The areas where erosion was found was usually on the posterior surface of the body, namely the occipital bone, spinous processes of the vertebrae, rib heads and proximal humeri (Eliopoulos 2006, 59). The preservation of the bones was affected by taphonomic processes, but to a minor extent since they were only buried for 3 or 4 years, recovery from non-specialists, and humidity and unstable temperatures in the ossuary.

3.2.2.4 Sex and age composition of the population

As has already been mentioned, there are written records sex, age, occupation, place of birth, cause and year of death for each individual from the Athens collection (Eliopoulos *et al.* 2007). The skeletal population sample is represented by both sexes and all age classes and is considered to be representative of the population of Greece, as the individuals of the assemblage came from many different parts of the country and from various socioeconomic backgrounds. The people whose remains comprise the collection died in Athens between 1960 and 1996 and their dates of birth range from the late 19th to the late 20th century. Although both their sex and age are known through the written records of the cemetery, these data were not used for the purposes of the present research. Instead, their sex and age were assessed using standard methods discussed in the *Methodology Chapter*, with the purpose to avoid bias when comparing the two populations, since biological sex, and particularly chronological age, do not correspond to skeletal sex and age. Thus, the sex and age composition presented in this section is based on the sex and age assessment.

In brief, of the 207 adult individuals of the population sample included in the present research, 94 (45.4%) were females and 113 (54.6%) were males. Twenty-nine (14.1%) of the individuals, regardless of sex, were young (20-35 years), 72 (35.0%) were middle (35-50 years) and 105 (51.0%) were older adults (50+ years). Out of 93 aged female individuals, 8 (8.6%) were young, 37 (39.8%) were middle and 48 (51.6%) were older adults; of the 113 male individuals, 21 (18.6%) were young, 35 (31.0%) were middle and 57 (50.4%) were older adults (Fig. 3.4).

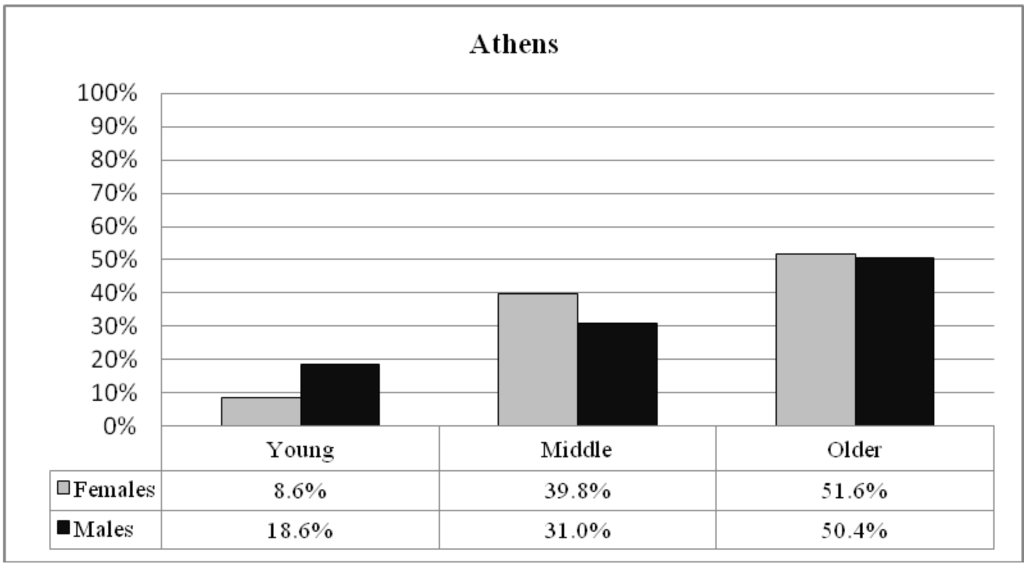

Figure 3.4: Sex and age composition of the Athens population sample

Comparisons between the sexes showed that a larger proportion of male individuals died between the ages of 20 and 35 years and a higher percentage of females lived after the age of 35 and 50 years. A higher risk of dying young and a shorter lifespan for males are typical in modern societies (Austad 2006).

Chapter 4

METHODOLOGY

The aim of this chapter is to discuss the rationale for selecting the particular dental health indicators and to specify in detail the methods adopted. The former provides the association between aims/questions/hypotheses and methods, and the latter clarifies the precise meaning of percentages in the results section, facilitates accurate comparison with other collections, and permits use of data by other investigators (Lukacs & Nelson 2001).

4.1 Sex Determination

Sex was assessed macroscopically, using a combination of morphological features supplemented by metric features, for all individuals who were determined to be approximately over the age of 18-20 years. Each individual was assigned a score for morphological features of the pelvis and the skull, according to the methods described by several researchers in the literature (Bass 1994; Buikstra & Ubelaker 1994; Phenice 1969; Ubelaker 1998; White 2000). Where the pelvis was present and clearly associated with the skull, the scores from the pelvis were combined with those from the cranium to produce a sex determination. The allocations of sex were also supported by a number of metric traits based on Bass (1994). As many traits as possible were recorded and the results from all three sets of observations and measurements were combined to determine the sex of the individual (Griffin & Donlon 2009). It should be noted that the sex of the skeletons from the modern assemblage was determined using the same methods employed for sexing the individuals from the archaeological population; the results of this assessment were used rather than the actual sex known from the cemeteries' written recor

All observations took place on both left and right sides of the pelvis and the skull, when these were present, but the expression most accurately reflecting the trait was recorded (Eliopoulos 2006). Some of the traits were scored simply as being present or absent, whereas for others a grading system was employed. More specifically, pelvic region traits were scored as follows:

- *Ventral arc*: 0=n/a, 1=present (F), 2=absent (M).
- *Subpubic concavity*: 0=n/a, 1=present (F), 2=absent (M).
- *Ischiopubic ramus ridge*: 0=n/a, 1=present (F), 2=absent (M).
- *Pubic bone shape*: 0=n/a, 1=rectangular (F), 2=intermediate (?), 3=triangular (M).
- *Pubic bone width*: 0=n/a, 1=broad (F), 2=intermediate (?), 3=narrow (M).
- *Subpubic angle*: 0=n/a, 1=wide (F), 2=intermediate (?), 3=narrow (M).
- *Greater sciatic notch*: 0=n/a, 1=wide & shallow (F), 2=F?, 3=?, 4=M?, 5=narrow & deep (M).
- *Preauricular sulcus*: 0=n/a, 1=wide & deep (F), 2=wide but shallow (F?), 3=well-defined but narrow (?), 4=narrow, shallow & smooth (M?), 5=absent (M).
- *Obturator foramen*: 0=n/a, 1=triangular (F), 2=intermediate (?), 3=oval (M).
- *Sacrum*: 0=n/a, 1=less pronounced curvature (F), 2=intermediate (?), 3=more pronounced curvature (M).

The skull traits observed and the grading system employed were the following:

- *Nuchal crest*: 0=n/a, 1=smooth, small (F), 2=(F?), 3=(?), 4=M?, 5=well-defined, large (M)..
- *Mastoid process*: 0=n/a, 1=small (F), 2=(F?), 3=(?), 4=(M?), 5=large (M).
- *Supraorbital margin*: 0=n/a, 1=sharp (F), 2=(F?), 3=(?), 4=(M?), 5=thick (M).
- *Glabella*: 0=n/a, 1=smooth, small (F), 2=(F?), 3=(?), 4=(M?), 5=robust, prominent (M).
- *Shape of frontal bone*: 0=n/a, 1=globular (F), 2=intermediate (?), 3=sloping (M).

- *Projection of mental eminence*: 0=n/a, 1=smooth, small, round (F), 2=(F?), 3=(?), 4=(M?), 5=large, prominent, broad (M).
- *Shape of mental eminence*: 0=n/a, 1=round (F), 2=?, 3=square (M).
- *Gonial angle*: 0=n/a, 1=obtuse (F), 2=intermediate (?), 3=approximating right angle (M).
- *Gonial eversion*: 0=n/a, 1=no eversion (F), 2=intermediate (?), 3=marked eversion (M).

All the above were scored following diagrams in Buikstra & Ubelaker (1994) and Bass (1994).

Metric data were obtained with an osteometric board and a Mitutoyo digital calliper. All measurements were applied on the left side. In cases where the left element was not present, damaged postmortem or it shape altered due to pathology, the right element was measured. The landmarks for measuring (a) the length of the glenoid cavity, (b) the vertical diameter of the humeral head, (c) the maximum diameter of the femoral head, and (d) the bicondylar breadth of the femur were obtained from Bass (1994). Measurements below a certain value are indicative of a female individual, whereas measurements above a specified point are indicative of a male individual. There is also an area of overlap between females and males and measurements that fall within this range cannot be sexed. The key for sex determination based on bone measurements follow Bass (1994) and is the following:

- *Length of glenoid fossa*: 0=n/a, 1=<34 mm (F), 2=34-36 mm (?), 3=>36 mm (M).

- *Vertical head diameter of humerus*: 0=n/a, 1=43 mm (F), 2=43-46 mm (?), 3=>46 mm (M).

- *Maximum head diameter of femur*: 0=n/a, 1=<43.5 mm (F), 2=43.5-46.5 mm (?), 3=>46.5 mm (M).

- *Bicondylar breadth of femur*: 0=n/a, 1=<74 mm (F), 2=74-76 mm (?), 3=>76 mm (M).

In cases where this combination of methods produced an ambiguous result, the pelvic traits were given priority, since, overall, the pelvis is the most accurate sex indicator in general (Buikstra & Ubelaker 1994) and in Greek populations in particular (Eliopoulos 2006), due to sexual differences related to pregnancy and childbirth in the female (Bruzek 2002; Buikstra & Ubelaker 1994). Individual traits were also given priority according to their reliability. In the pelvis, for instance, the preauricular sulcus, subpubic concavity and ventral arc were given priority as they are probably more accurate than other secondary sex characters in Greek populations. This "hierarchy" was based on the preliminary results of a study by Eliopoulos (2006) on the application of sexing and ageing standards on the modern skeletal population ("Athens Collection") (Eliopoulos 2006, 114), which was also studied for the purposes of the present research. Similarly, in the skull, the supraorbital ridges and the shape of the mental eminence were given priority rather than other traits (Eliopoulos 2006, 118), whereas bicondylar breadth of the femur and the vertical diameter of the humeral head were given priority to femoral head diameter and glenoid fossa length (Eliopoulos 2006, 120).

The classifications that were followed were: (a) *female*, (b) *probable female*, (c) *undetermined sex*, (d) *probable male*, and (e) *male*. Although the classification included the category *undetermined sex*, as mentioned earlier in the *Materials Chapter*, individuals of indeterminate sex were not included in the study. When only unreliable or a small number of traits, either morphological or metric, were available for study, or when there was an overlap of female and male traits, then the individual was assigned to the *probable female* or *probable male* categories. In order to facilitate the presentation and interpretation of the results, however, in the *Results* and *Discussion Chapters*, individuals assigned to the *probable female* category were regarded as females and those assigned to the *probable male* category as males.

4.2 Age Estimation

Age was assessed macroscopically, using a combination of osseous and dental criteria, for all individuals who were determined to be approximately over the age of 18-20 years. The methods used provide an estimation of the skeletal age that may be far from chronological age, i.e. the number of years a person has lived since birth. In order to avoid comparisons between an ancient assemblage aged by dental and osseous criteria and a modern assemblage of known chronological age, it was felt appropriate to estimate the age of the skeletons of the modern assemblage, instead of using the age information from the written records. Age estimation was based on the following methods, in descending order of reliability:

(a) final stages of skeletal and dental maturation, e.g. iliac crest, medial clavicle, sacrum, eruption of third molar, etc. (Bass 1995); this method only applied to some of the skeletons.

(b) the Suchey-Brooks pubic symphysis morphology system (Brooks & Suchey 1990; Suchey & Katz 1986).

(c) the auricular surface morphology scoring system (Lovejoy *et al.* 1985; Meidl & Lovejoy 1985).

(d) sternal end of ribs (Iscan *et al.* 1984; 1985).

(e) dental attrition (Smith 1984).

(f) cranial suture closure scoring technique (Meidl & Lovejoy 1985).

The latter method of dental occlusal attrition was used in the archaeological population only, since the method has been tested on earlier populations, in which dental wear was much heavier than in industrial populations. Whenever possible, a combination of these methods was employed, in order to provide a more reliable outcome. However, when there was inconsistency in the results, the pubic-symphysis method was prioritised in younger individuals, as it produces underestimates in older adults (Meidl & Lovejoy 1985), whereas the auricular surface system was considered more reliable in older individuals (Lovejoy *et al.* 1985). The cranial suture closure was considered the less reliable of all, as the recent study of Eliopoulos (2006) on the modern population from Athens indicated that there was no strong correlation between estimated and actual age.

The age categories that were used in this thesis were the following: 20-35 years (*young adult*), 35-50 years (*middle adult*), and 50+ years (*older adult*). The minimum age of 20 years was defined by complete fusion of long bone epiphyses. The maximum age of 50 rather than 60 years, which is the maximum that ageing methods can yield, was established because distinguishing between a 50 and a 60 year old may be rather problematic. It was decided to allocate individuals into three age categories instead of five or more, in order to facilitate comparisons among age-groups. The purpose was also to minimise errors of assigning skeletons in middle age categories, since after the age of 30, it is difficult and inaccurate to narrow down an individual to a five-year or a ten-year age group. It is much easier to say that a skeleton belongs to the "35-50 years" category, if it does not show either young enough to be allocated in the range 20 to 35 years nor old enough to be assigned in the "50+ years" cateogory.

4.3 Terminology

The term *population* is used as a synonym for *population sample* and *population assemblage* (or simply *sample, assemblage, collection*, etc.), and refers to the subset of the once living population of Demetrias and Athens, which is represented by the individuals comprising the two collections (Waldron 1994). The term *prevalence* is defined as the total number of cases of a lesion or a condition in the population sample under study, divided by the number of individuals, teeth or tooth surfaces/regions observable in that sample. *Frequency* is used as a synonym for *prevalence*, and has the same meaning, but, in the *Results Chapter*, it is most frequently used when referring to the percentages of pathological tooth or tooth surfaces/regions rather than the percentage of individuals affected. The term *rates* is also used as a synonym for *frequency* and *prevalence*. Abbreviations were used for socioconomic status (SES), antemortem tooth loss (AMTL) and dental defects of enamel (DDE).

The terminology employed for dental pathologies and wear was based on that of Hillson (1996; 2001; 2005), Wasterlain *et al.* (2009), Smith (1984) and Kerr (1988). *Tooth type*, in this study, is used to refer to a specific tooth in the dentition, regardless of side, e.g. maxillary first incisors. The term *tooth class* refers to four categories: *incisors*, *canines*, *premolars* and *molars*.

Wear is a multifactorial process that results from three main interacting mechanisms, i.e. *attrition*, *abrasion* and *erosion* (Kaidonis *et al.* 1988 cited by Watson 2008). The term *wear* may refer to any of these three mechanisms or it may be used to denote a combination of *attrition* and *abrasion* or of all three of them. *Attrition* is caused through friction, by tooth-on-tooth contact in the absence of food or other abrasives (Watson 2008). *Abrasion* is caused by contact between the tooth and the food or other solid exogenous materials, especially as food is forced over occlusal surfaces (Larsen 1997, 247). *Erosion* is the loss of tooth materal due to non-bacterial exogenous or endogenous chemicals (Kieser *et al.* 2001). Firstly because of the difficulty of distinguishing *attrition*, *abrasion* and *erosion*, and secondly due to the fact that the recording of different types of wear is outside the scope of the present study, this discussion regards *wear* as including any combination of the three. However, the terms *wear* and *attrition*, and *occlusal wear* and *occlusal attrition*, are used as synonyms.

Periodontal disease, although is often referred to in the singular, it represents various inflammatory conditions of the gums and the periodontium (Costa 1982). In the present thesis, the term refers to all pathological stages/categories of the system employed in this study (Kerr 1988), including *gingivitis,* which is a chronic inflammation of the gums (Costa 1982). *Periodontitis*, although it has the same meaning as periodontal disease, in this study, it refers to all other stages/categories of the disease except from *gingivitis*. The terms *septa*, *septal areas*, *interseptal areas* or *interdental septal areas* all refer to the dividing bony walls between adjacent tooth sockets.

Dental enamel defects is a term that generally indicates several different types of defects, such as *hypoplasia*, *opacities* and *discolourations* (Hillson 1996, 165).

However, in this thesis, although only *hypoplasia* was studied, *dental enamel defects* refer to *enamel hypoplasia* the two terms are used as synonyms.

4.4 Tooth Assemblage Preparation and Assessment of Tooth Type

The teeth were taken out of storage bags, cleaned with a soft toothbrush and cotton buds to remove soil and mud, soil, dust or debris, rinsed thoroughly with tap water and left to dry at room temperature. Each tooth was identified according to its type, class, side and arch. The nomenclature used for recording teeth was based on the Fédération Dentaire Internationale (FDI) system (1971). As has already been mentioned, interseptal areas are the areas between two adjacent tooth sockets. Thus, it was decided to "name" each interdental area after the FDI numbers of the two teeth belonging to the adjacent sockets (Hillson 2001); for instance, the interseptal area between upper right first molar and upper right second molar, was named: "16-17". Only teeth, and interseptal areas for that matter, that could be identified as belonging to a particular individual were selected for the study, and only those that could be allocated to a tooth type were considered from each individual.

4.5 Dental Examination

Teeth were examined for presence, antemortem tooth loss, postmortem absence, partial eruption, anomalous eruption, or no eruption as a result of young age, agenesis or impaction. It was assumed that a tooth had been lost antemortem when there was trace of remodelling in the socket or alveolar process. Third molars were recorded as lost antemortem only in cases where thay had left distinct traces of approximal wear on the distal surface of the adjacent second molar (Wasterlain *et al.* 2009). Postmortem tooth loss was assumed when there was an empty alveolus with no sign of remodelling. Only fully erupted teeth were used for further calculations because partially erupted teeth might have been covered by soft tissue in life (Lingstrom and Borrman 1999 cited by Wasterlain et al. 2009).

4.6 Dental Caries

4.6.1 How dental caries meets the aims of the present study

Caries, which is the commonest of all types of dental disease, was selected because it is the major source of information on diet and how this changed through time and according to sex and social status. The frequencies of carious lesions in industrial populations are markedly higher and severer than in the pre-industrial (Hillson 2008) populations, mainly because of refined sugar and carbohydrates in the diet of the former (Keenleyside 2008). Comparisons between the sexes often reveal a higher prevalence in females (Hemphill 2008) attributed to biological and behavioural factors, although this is not always the case (Moore & Corbett 1973). Similarly, there is growing evidence to suggest that members of different social rankings did not consume the same foods or have the same dietary habits and, consequently, they showed contrasting patterns of caries (Hemphill 2008; Polk *et al.* 2009). Therefore, caries can shed light on issues regarding the relationship between socioeconomic conditions and oral pathology, which is the main focus of the present study.

4.6.2 Method for recording dental caries

The recording of carious lesions was obtained macroscopically by careful visual inspection, with the aid of a magnifying mirror and a strong source of light. The use of a microscope and radiographs was not possible as these were not available in the Laboratory of Biological Anthropology, University of Athens, and financial support was very limited. Previous studies, however, have reported that naked-eye examination alone was sufficient to make adequate diagnosis of dental caries and that it was more reliable when compared to both radiographic and histological studies (Whittaker *et al.* 1981; Kerr et al. 1988; 1990; Whittaker and Molleson 1996 cited by Albashaireh & Al-Shorman 2008). All teeth were examined twice by direct inspection with a two-week interval by the same examiner. Only those surfaces that were considered to be carious at both examinations were taken into account.

Recognising, scoring and reporting dental caries followed guidelines and recommendations by Hillson (2001), with some modifications, omissions and additions by the author of this thesis. According to this scheme, caries, along with all the essential related information about occlusal and approximal attrition, enamel defects, ante-mortem and post-mortem tooth loss were recorded for each tooth and tooth surface separately in a single recording form. Carious lesions were not recorded simply as being present or absent for each tooth. Instead, there were different categories of observation for each lesion, which were noted as number codes.

The particular recording scheme has been employed because one of the objectives of the present research was to record caries in more detail than has been the case in most archaeological studies and to avoid interpretation bias inherent in simpler methods. This aim was set mainly because caries "has no precisely defined fixed points at which a diagnosis of 'carious' and 'non-carious' can be made (Hillson 2001, 259). The process of demineralisation is in a continuous, slow and irregular development and, therefore, any diagnostic criterion selected is arbitrary. It has been common practice to record dental caries simply as being present or absent and, as a result, neither the severity (stage of development) of the lesion nor the position on the tooth surface have been recorded. A further parameter that is often not taken into account is the possibility that a tooth might be affected by more than one carious lesion and, therefore, when only presence/absence of a lesion is recorded only, there is an underestimate of caries severity, in terms of number of lesions in each tooth. Moreover, many surveys in archaeological populations have recorded only those lesions penetrating the dentine. Such procedures, however, underestimate caries prevalence (Hillson 2001), since they do not take into account carious lesions at the earlier stages of development, i.e. enamel lesions.

Another negative aspect of many studies is that no distinction is made among tooth classes and types, and even more often, among tooth surfaces of certain tooth classes and types but rather they report and make interpretations based on the average number of carious teeth per dentition. Such average caries rates, however, disregard caries susceptibility exhibited by tooth classes and types and by tooth sites (Batchelor & Sheiham 2004; Hillson 2008). Numerous studies have shown that the development of dental caries within the dentition follows a hierarchy indicating that tooth surfaces show a variation in caries susceptibility (Batchelor 1998; Batchelor & Sheiham 2004; Eklund & Ismail 1986; Poulsen & Horowitz 1974). Left and right sides are equally affected by coronal caries, but upper teeth, especially the anterior, are more frequently involved than lower teeth. Posterior teeth, particularly molars, are far more susceptible to caries than anterior teeth (Hillson 2001, 251-252). Tooth sites also exhibit a hierarchy of susceptibility, whereas some of them can be grouped. According to a study by Batchelor & Sheiham (2004), the most susceptible group consists of first molars and, more specifically, the buccal pits and occlusal fissured surfaces of the first molar teeth. The second group consists of second molars and buccal surfaces lower second molars and occlusal surfaces of all second premolars. The group formed by the least susceptible sites includes the largest number of tooth surfaces and consists of the majority of the lower incisors and canines (Batchelor & Sheiham 2004, 1). The important finding is that this hierarchy appears to remain the same, regardless of fluorine in toothpaste and water, and level of dental health care (Hillson 2001).

The disregard of caries susceptibility hierarchy makes it impossible to detect distribution patterns within the dentition, and, most importantly, it may underestimate or overestimate caries frequency rates. The pattern of postmortem and antemortem tooth loss has a strong effect in this. Caries rates are much higher in posterior teeth but anterior teeth are much more likely to be lost postmortem, so that, in a population sample where preservation is good and the anterior teeth survive, the caries frequency is depressed in comparison with a sample with poor survival of anterior teeth (Hillson 2001). Antemortem tooth loss, on the other hand, is more common on the posterior teeth, especially molars, and, therefore, in a population assemblage where many posterior teeth are missing antemortem, the caries frequency is again depressed when compared to an assemblage with only a few posterior teeth missing antemortem. Obviously, because of the fact that antemortem tooth loss is in most cases a result of caries (Albashaireh & Al-Shorman 2010), if a method such as the caries correction factor (Lukacs 1995), which takes into account antemortem tooth loss when calculating caries frequency, is employed, then the effect of antemortem tooth loss is much weaker.

Differential preservation constitutes a major problem in studies of pathological conditions in osteological populations and this is the case for skeletal as well as dental remains. Hence, the recording system needs to take account of the fact that, apart from whole teeth, parts of teeth may also be missing or certain sites may be unobservable and "caries should be reckoned in relation to the preservation of the sites on the teeth that would be capable of registering the different types of lesions" (Hillson 2001, 272).

The most important advantage of the methodology employed here is that all the above were taken into consideration and several classes of lesions with different aetiologies were recorded. Thus, according to Hillson (2001), the location, site of origin, stage of development and extent of lesions were recorded. The locations that were considered were the following: (a) *occlusal surfaces,* including *occlusal attrition facet*, (b) *pit sites*, (c) *mesial* and (d) *distal contact areas*, (e) *mesial* and (f) *distal root surfaces*, (g) *buccal* and (h) *lingual enamel smooth surface sites*, and (i) *buccal* and (j) *lingual root surfaces*. A lesion was classified as *gross* when it was too large for the initial location of the site of attack to be determined with certainty, and as *gross gross* when involving the loss of so much of the tooth that it was not possible to determine whether the lesion was initiated in the crown or root (Hillson 2001; Wasterlain *et al.* 2009, 4-5).

Some aspects were recorded for the whole tooth and other aspects for particular sites on each tooth. Tooth presence recording followed guidelines by Hillson (2001) and, according to them, each whole tooth had to be classified into one of the following categories:

- missing postmortem and jaw with socket missing too.

- tooth present, without gross caries.
- gross carious cavity.
- gross carious cavity with opening into an exposed pulp chamber.
- tooth missing antemortem, with full remodelling of the jaw to leave level contour.
- no evidence that the tooth has ever erupted (young age, impaction or agenesis).
- tooth partly erupted.
- anomalous eruption (not normal position in the tooth row).

After recording each tooth as a whole, each seperate tooth surface, previously mentioned, was recorded for the presence of *enamel*, *dentine* and *pulp exposing* lesions in the crown and the root of the tooth separately. In cases where there was more than one lesion on the same surface, then, the deepest one was scored. For *coronal caries*, the categories (represented by code numberings in the parentheses) were the following:

- site present but enamel translucent and with a smooth surface (0).
- white or stained opaque area in enamel (1).
- stain opaque area in emamel with roughening (2).
- small cavity, where there is no evidence that it penetrates to the dentine (3).
- discolouration of exposed dentine of an approximal attrition facet (4).
- larger cavity, which clearly penetrates the dentine (5).

- large cavity, which was clearly initiated in the particular surface under observation, within the floor of which is the open pulp chamber, or open root canals (6).
- gross cavity too large for the initial location of the site of attack to be determined with certainty (7).
- gross gross caries with open pulp chamber, or open root canal, when involving the loss of so much of the tooth that it was not possible to determine whether the lesion was initiated in the crown or root (8).
- filling (9) (for the modern assemblage only).

It should be noted that the above categories did not apply to all tooth surfaces/sites.

Root surface carious lesions are initiated either at the cement-enamel junction or on the root surface nearby; however, in archaeological material, it is often impossible to distinguish between the two initiation sites and, for that reason, the two were combined as *root surface caries* (Hillson 2001, 273). The roots were, thus, scored as follows:

- root surface/enamel-cement junction preserved and observable, with no evidence of staining or cavitation (0).
- area of darker staining along cement-enamel junction or on root surface (1).
- shallow cavity, following the line of the cement-enamel junction or confined to the surface of the root (5).
- cavity involving the cement-enamel junction, or root surface alone, within the floor of which is the open pulp chamber, or open root canals (6).

- gross cavity, including the cement-enamel junction, or root surface, which involves the neighbouring crown side, occlusal or pit sites or occlusal attrition facet sites (7).
- gross cavity, defined as above, within the floor of which is the open pulp chamber, or open root canals (8).
- filling (9).

4.6.3 Calculating dental caries frequency

Given the fragmentary nature of osteological material, the variation in caries susceptibility (Batchelor & Sheiham 2004), as well as the multifactorial nature of antemortem tooth loss (Lukacs 2007), it is rather difficult to estimate the proportion of individuals affected by caries, as the status of missing teeth can never be known (Wasterlain *et al.* 2009). Moreover, as already mentioned in 4.7.2, another difficulty is that differential preservation also concerns surfaces and parts of teeth (Hillson 2001). With all these in mind, it was decided that the calculation of the number of both teeth and tooth surfaces/regions/sites observed to be affected by caries as a percentage of all teeth and tooth surfaces/regions/sites present in the assemblage to be the most accurate method for estimating caries prevalence. Separate tabulations for the different categories of carious lesions, at the different sites on the tooth surfaces where they may have been initiated were made (Wasterlain *et al.* 2009). Antemortem tooth loss was calculated as the percentage of tooth positions in the maxillae and mandibles from which the tooth had been lost during life (Wasterlain *et al.* 2009).

The conventional caries frequency, i.e. the number of carious teeth out of the total number of observable teeth in a skeletal series, does not reflect the real prevalence of caries because carious teeth lost antemortem and postmortem are not accounted for. In living populations, caries rates are calculated counting the number of decayed, missing and filled teeth (DMFT index) (Daneshkazemi & Davari 2005). In skeletal populations, however, such methods are not suitable for several reasons, including assumptions that most antemortem tooth loss results from tooth decay (Lukacs 1995, 152) and not differentiating among tooth types. Thus, whereas caries frequencies estimated from carious teeth observed alone underestimates actual caries prevalence, the DMFT index overestimates the actual prevalence (Lukacs 1995), especially in ancient populations that experience heavy occlusal attrition, severe periodontal disease and frequent episodes of dental trauma. For these reasons, a method 'that permits the formulation of a correction factor that is uniquely specific to the human skeletal series under investigation' is required (Lukacs 1995, 152). The caries correction factor proposed by Lukacs (1995) was employed in the present research as it calculates directly from the frequency of dental lesions 'that are key causal agents in precipitating antemortem tooth loss' in the skeletal series under study (Lukacs 1995, 152).

According to Lukacs (1992; 1995), the prevalence of antemortem tooth loss is calculated as the number of teeth determined to have been lost before death divided by the total number of teeth present in the skeletal population prior to any tooth loss (teeth observed), plus the number lost antemortem. The exact steps that were followed in order to estimate corrected caries rates (Lukacs 1992; 1995) were the following:

a. estimated number of teeth lost due to caries: [*number of teeth lost antemortem*] x [*proportion of teeth with pulp exposure due to caries*]

b. total number of teeth with caries: [*estimated number of teeth lost due to caries*] + [*number of carious teeth observed*]
c. total number of original teeth: [*number of teeth observed*] + [*number of teeth lost antemortem*]
d. corrected caries rate: [*total estimated number of teeth with caries*] + [*total number of original teeth*]

However, because of the fact that it is impossible to know what proportion of antemortem tooth loss may have resulted from dental caries, and caries corrective factors make such assumptions (Wasterlain 2009, 5), the corrected rates were not the only ones that were taken into account when interpreting the results of the present study. Instead, their interpretation was based on a combination of factors. Moreover, the corrective factors were applied only in cases where it was felt that they would shed some light in the patterns observed, if combined with the uncorrected caries rates. More specifically, the frequencies estimated and taken into consideration when interpreting the results were:

(a) the individual count prevalence, which is the percentage of individuals with at least one carious lesion, that is the number of individuals affected divided by the total number of individuals available for observation.

(b) the tooth count prevalence, which is the percentage of teeth with dental caries (regardless of lesion severity), that is the number of carious teeth divided by the total number of teeth observed.

(c) the tooth surface count prevalence, which was the percentage of tooth surfaces/sites, i.e. occlusal, pit, occlusal attrition facet, contact (mesial and distal), smooth surface (buccal and lingual), root surface (mesial, distal, buccal and lingual) with caries, that is the number of carious tooth surfaces/sites divided by the total number of observable tooth surfaces/sites.

(d) the proportion of individuals with cavitated lesions (at least one cavitated lesion).

(e) the proportion of teeth with cavitated lesions.

(f) the proportion of individuals with only one decayed tooth.

(g) the average number of lesions per mouth, in cases where this was considered to be informative.

(h) the prevalence of each one of categories 1, 2, 3, 4, 5, 6, 7, 8 and 9 for coronal caries, and 1, 5, 6, 7, 8 and 9 for root caries.

(i) the prevalence of each one of categories 1, 2, 3, 4, 5, 6, 7, 8 and 9 for coronal caries, and 1, 5, 6, 7, 8 and 9 for root caries, for each tooth surface separately (i.e. occlusal, pit, occlusal attrition facet, mesial, distal, buccal, lingual, mesial root, distal root, buccal root and lingual root surfaces).

To facilitate the statistical analysis as well as the presentation and interpretation of the results, the nine (1-9) categories for coronal caries in Hillson's (2001) system, were reduced to three groups. Thus, the findings for coronal caries were categorised as: *enamel lesions* (codes 1 and 2), *dentine lesions* (codes 3, 4, 5 and 7), *pulp lesions* (codes 6 and 8). The six root caries categories (Hillson 2001) were reduced to only one group and were altogether categorised as *root caries* (codes 1, 5, 6, 7 and 8). Based on this modification, the following were also estimated:

(j) the prevalence of teeth with enamel lesions, dentine and pulp lesions, and root caries.

(k) proportion of carious tooth surfaces with enamel, dentine and pulp lesions, and root caries.

In addition to the above, frequencies of teeth lost antemortem, missing postmortem and with eruption-related problems were also measured. More specifically, the percentages that were calculated were as follows:

(l) the percentage and number of observable tooth sockets.

(m) the percentage and number of teeth lost antemortem.

(n) the percentage and number of teeth lost postmortem.

(o) the percentage and number of teeth with eruption problems.

(p) the percentage and number of teeth observable for recording dental caries.

It should be noted that, in addition to overall (regardless of tooth class or type) frequencies of dental caries, antemortem tooth loss, postmortem tooth loss and eruption problems, all the above were also estimated for each tooth type separately. This issue, however, is further discussed later on in this chapter, alongside the patterns according to sex, age and socioeconomic status.

4.7 Dental Wear

4.7.1 How dental wear meets the aims of the present study

Wear can be very informative regarding diet. Both wear rate and pattern have been shown to change rather dramatically when human groups alter their food behaviours in subsistence, consumption and processing techniques (Watson 2008, 92), or when there is dietary variation between skeletal assemblages or subgroups within skeletal assemblages (Larsen 1997, 257-258). Both sex and social rank differences have been identified in past societies; these differences are the result of easier access to certain “high status” food and drink items by the socially advantaged members of society, e.g. males and the "elite". Consequently, wear, in combination with caries and antemortem tooth loss, can offer further insight into diet, in general, and into status differences between the sexes and the socioeconomic classes. Various hypotheses can be tested; these include the assumptions that sex status differences, in both Demetrias and Athens, existed and that this was reflected in dietary variation, and that the presence/absence of grave goods, in Demetrias, does not reflect socioeconomic status in life.

The second reason for selecting the specific indicator was its relation to dental caries and antemortem tooth loss. The frequency of occlusal surface (i.e. fissure and pit) caries at a population level tends to be inversely related to the severity of occlusal attrition (Hall *et al.* 1986; Hillson 1996). It has been suggested that this inverse relationship is the result of the higher fibre content and abrasive quality of the diet, promoting rapid wear that removes the fissures before they become carious (Hillson 2001, 263; Manji *et al.* 1990). In other words, softer, non-abrasive foods are more cariogenic, and unworn surfaces, especially those of molars that are markedly the most frequently caries-affected tooth class, concentrate more food and retain it for longer than worn surfaces (Powell 1985). Approximal attrition between neighbouring teeth may also remove carious tissue (Kerr *et al.* 1990). However, caries often proceeds more rapidly than wear, especially in the mesial and distal contact areas, where approximal attrition is much slower than occlusal (Hillson 2001).

An alternative view is that wear is positively related to caries, as it predisposes to chipping of teeth and creating traps for dental plaque to accumulate, as well as exposing lines of weakness for the extension of a carious lesion, or exposing areas of dentine (Hillson 2001, 263). The areas of exposed dentine are particularly susceptible to caries because the demineralisation of dentine does not require such a low pH as that needed to demineralise enamel (A. Sheiham, *pers. comm.* cited by Hillson 2001). Approximal spaces, in which food can be trapped, are also created by wear, and thus encourage plaque accumulation (Hillson 2001, 264). Furthermore, tooth wear is strongly related to root surface caries, but in a different, indirect way. When the occlusal surface is worn away, the height of the crown is decreased. The tooth makes an axial movement to compensate for occlusal tooth substance loss until a contact with its antagonist takes place (Albashaireh & Al-Shorman 2010). This leads to greater exposure of interproximal and root surfaces, which become new targets for caries. The exposure of the root surfaces makes the root more vulnerable to caries, especially the mesial and distal surfaces near stagnation areas, which are interproximal regions immediately beneath contact areas between two adjacent teeth (Albashaireh & Al-Shorman 2010, 211). Continuous eruption due to wear, may also result in antemortem tooth loss (Arnold *et al.* 2007).

The third reason for recording occlusal wear was to estimate the age of individuals from the ancient population (Brothwell 1981). In some cases, the only method that could be employed for ageing was that of occlusal attrition (Smith 1984). Thus, wear was proved to be particularly useful because it contributed to maximising the Demetrias sample size, since age was one of the inclusion criteria (discussed in 3.1.2.2).

4.7.2 Method for recording dental wear

All the above indicate that it was necessary to record dental wear in the samples under study, in order to determine its association with tooth decay. This was particularly important in the present study, where there is a comparison between an archaeological and a 20th century population, as the rate of wear in ancient populations is much higher than that in modern populations.

Tooth wear was recorded following the Murphy system (1959) of occlusal attrition, as modified by Smith (1984), adding a category for fractured teeth showing some sign of wear (Hillson 2001). According to this method, wear is recorded along an eight-point scale, based on the amount of exposed dentine. More specifically, each occlusal surface was scored as follows:

- no dentine exposure / unworn to polished small facets.
- moderate exposure.
- dentine exposure of distinct thickness / full cusp removal.
- large dentine exposure.
- large enamel rim lost / dentine areas coalesced.
- enamel rim lost / large dentine exposure and enamel rim intact.
- severe loss of crown.
- tooth fractured, leaving a surface that shows some wear.

4.7.3 Measuring dental wear

To facilitate the statistical analysis, presentation and interpretation of the results, the stages in Smith's (1984) method were reduced to three groups according to the different 'polished enamel/dentine' exposure patterns of the occlusal surfaces: slight wear (stages 1 and 2); moderate wear (stages 3 and 4) and heavy wear (stages 5, 6, 7 and 8) (Bonfiglioli *et al.* 2003, 38). However, comparisons between populations and subsets within population assemblages were also made for each one of the eight stages in Smith's (1984) system.

More specifically, the frequencies estimated and taken into consideration when interpreting the results were the following:

(a) the individual count prevalence, which is the percentage of individuals with occlusal wear, that is the number of individuals with worn teeth divided by the total number of individuals available for observation.

(b) the tooth count prevalence, which is the percentage of teeth with occlusal wear (regardless of severity), that is the number of worn teeth divided by the total number of teeth observed.

(c) the tooth count prevalence, i.e. the percentage, of teeth with (a) slight, (b) moderate, and (c) heavy occlusal wear.

(d) the tooth count prevalence, i.e. the percentage, of teeth falling into each one of the eight stages in Smith's (1984) scoring system.

All the above were also calculated for each tooth class and tooth type separately, in order to avoid differential preservation bias. These, in addition to overall (regardless of tooth class and type) frequencies, were also taken into consideration when interpreting the results.

4.8 Periodontal Disease

4.8.1 How periodontal disease meets the goals of the present study

Periodontal disease is multifactorial in origin and involves inheritance, but also environment, diet and oral hygiene (Hillson 1996, 269). However, although most of these factors differ significantly between premodern and modern populations, studies on periodontal disease have revealed that the prevalence and severity of the condition has not changed much in relation to the past (Kerr 1998; Meller *et al.* 2009). The present study provides the opportunity to explore the relationship of periodontal disease and predisposing factors that are importantly affected by socioeconomic conditions (Oztunc *et al.* 2006). Periodontitis prevalence and severity is also regularly reported to differ between the sexes (Reynolds *et al.* 2009) and according to social ranking (Sabbah et al. 2007); thus, in combination with caries, antemortem tooth loss and wear, it can contribute to a better understanding of the indirect relationship between socioeconomic status and oral health. Additionally, periodontal disease can provide a more complete picture of oral health status and further insight into the association among oral conditions, as one of its possible consequences is antemortem tooth loss (Costa 1982; Hillson 2005).

4.8.2 Method for recording periodontal disease

The assessment of periodontal disease in archaeological populations has always been problematic. Perhaps the main negative aspect is that it has been primarily based on estimates of the extent of alveolar bone loss. Most studies have relied on the distance from the alveolar crest to the cement-enamel junction (Meller *et al.* 2009; Tsilivakos *et al.* 2002) and categories such as 'mild', 'moderate' and 'severe', based on the degree of root exposure, have been suggested (Brothwell cited by Kerr 1988; Costa 1982; Meller *et al.* 2009). Such techniques, however, heavily rely on subjective interpretation (Kerr 1988); moreover, they are unreliable given that hypereruption related to occlusal attrition has often misidentified as periodontitis (Klaus & Tam 2010). The assumption that alveolar bone crest to amelo-cemental junction distance accurately reflects the degree of inflammatory periodontal attachment loss was disputed by the work of Darling & Levers (1975), Newman & Levers (1979) and Levers & Darling (1983), who showed that teeth with marked occlusal attrition underwent the phenomenon of 'supereruption' or 'compensatory coronal migration' (Kerr 1988, 67-68). Such coronal movement of teeth past a vertically stable periodontium has the effect of increasing the alveolar bone crest to enamel-cementum junction distance (Kerr 1988, 68). Therefore, an increase in this dimension may be a reflection of occlusal attrition and continuous eruption, but it may also be the result of inflammatory periodontal attachment loss or even of both attrition and periodontitis (Kerr 1988, 68). Considering that the teeth of the ancient population under study here show signs of heavy occlusal attrition, the recording system recommended by Kerr (1988) was considered to be the most suitable in this case. In addition, the method of measuring the distance of alveolar bone crest to amelo-cemental junction requires the presence of teeth in situ, which can considerably reduce the amount of material that can be included in studies where only hard tissues are available (Kerr 1988).

The Kerr (1988) system of assessment, employed in this research, avoids linear measurements of root exposure (Kerr 1998b) and is more objective and reliable, as it relies upon on the textural and architectural variations of the interdental septum (Oztunc *et al.* 2006). The interdental septal bone was chosen because of its vulnerability to periodontal disease (Mason 1976 cited by Kerr 1988). Kerr's (1988) method is based on Costa's (1982) study and focuses attention on the site of the pathological lesion rather than estimating bone loss that might arise from several different factors. According to it, different grades of architectural form and surface textural changes are distinguished in order to assess the periodontal status of a population. The features in the five categories described by Kerr (1988) corresponded to those observed in septal areas clinically diagnosed as displaying gingivitis or undergoing an acute burst or quiescent periodontitis.

The Kerr (1988) method required all septa to be viewed at 10x magnification (Kerr 1998a, 132) under a strong source of both natural and fluorescent light. All the observations in this study were made twice by direct inspection with a two-week interval by the author. Examination of the alveolar bone was confined to the interdental areas adjacent to fully erupted permanent teeth (Kerr 1988) but did not require teeth to be present and/or in situ. Septal areas were examined in respect of (a) the contour of the septum judged in the bucco-lingual direction and (b) the nature of the bone surface in respect of the type and degree of osseous disruption it displayed (Kerr 1988, 68). Septa adjacent to teeth lost antemortem and those septa showing postmortem damage were considered *unrecordable* (Category 0 in the recording system).

Interdental septum demonstrates the following characteristic defects in proportion to the progress of periodontal disease:

- *Healthy*: the cortical surface is smooth and virtually uninterrupted by foramina or grooves (Category 1).
- *Gingivitis*: cortical surface showing a range from many small foramina and/or shallow grooves to a cortical surface showing larger foramina and/or prominent grooves or ridges (Category 2).

- *Acute burst of periodontitis*: septal form showing a breakdown of contour with bone loss in the form of a shallow depression extending across the interspace from the buccal to lingual aspect, or as one or two smaller discrete areas of bone destruction, the essential distinguishing feature being a sharp and ragged texture to the bone defect (Category 3).
- *Acute burst of periodontitis in a quiescent phase*: septal form showing breakdown of contour with bone loss similar to that seen in the previous category, the essential difference being that the bone surface, instead of being ragged in appearance, shown a porous or smooth honeycomb effect with all defects rounded (Category 4).
- *More progressive periodontitis*: presence of a deep intra-bony defect with sides sloping at 45 degrees or more and with a depth of 3mm or more. The defect is more likely to be mesio-distally but may be bucco-lingually inclined. The surface may be sharp and ragged or smooth and honeycombed (Category 5).

Interseptal areas that showed signs of localised textural changes and were adjacent to teeth with deep carious lesions affecting the pulp were excluded since inflammation of the pulp may also result in alveolar bone absorption (Tsilivakos 2002, 51). For the same reason, interseptal areas adjacent to teeth with pulp exposure due to occlusal attrition that signs of localized defects were also not included. Caries constitutes one of the ways oral bacteria may gain access to the pulp, but other factors may be associated, especially in cases where there are severe localised lesions but no signs of dental caries or periapical inflammation related to heavy attrition (Hillson 1996, 265). Such factors include cultural practices, such as tooth grooving, and anatomical defects, such as the failure of cementum to cover the entire tooth surface (Clarke 1990, 373).

Thus, two patterns of bone loss are recognised: horizontal and vertical; whereas 'horizontal bone loss describes simultaneous loss in height of all walls - approximal, buccal and lingual - surrounding the tooth roots and also implies that several neighbouring teeth are involved, or even the whole dental arcade' (Hillson 1996, 263), 'vertical bone loss is localised around individual teeth, or pairs of individual teeth, to form an 'intrabony defect' surrounded by high walls of unaffected bone' (Hillson 1996, 264). Therefore, lesions resulting from pulp inflammation should be differentiated from lesions that are caused by generalised inflammation of the periodontium (*horizontal periodontitis*) (Clarke 1990; Costa 1982). As has already been mentioned, in the present study, the scoring scheme developed by Kerr (1988; 1991) was employed to record horizontal or generalised periodontitis. Vertical or localised alveolar bone loss was also recorded using the Karn *et al.* (1984) system, which classifies non-uniform defects of the alveolar process into: loss of alveolar bone lining the tooth socket: (a) *crater*, (b) *trench,* (c) *moat*; loss of alveolar bone and outer cortical plates: (d) *ramp*, (e) *plane*; combinations: (f) *cratered ramp*, (g) *ramp into crater*. However, the results for vertical/localised periodontitis, based on the Karn *et al.* (1984) system, are not presented in this thesis, due to space limitations; when these are published, along with the results for horizontal periodontitis (Kerr 1991), a more complete picture will emerge.

4.8.3 Calculating periodontitis frequency

In summary, the following mean proportions were calculated:

(a) the individual count prevalence, which is the percentage of individuals with gingivitis and periodontitis, that is the number of individuals affected divided by the total number of individuals available for observation.

(b) the interseptal area count prevalence, which is the percentage of interseptal areas with gingivitis and periodontitis, that is the number of interseptal areas divided by the total number of interseptal areas observed.

(c) the interseptal area count prevalence for gingivitis, acute burst of periodontitis, quiescent phase of periodontitis and progressive periodontitis.

The method of Kerr (1988) was modified in order to estimate the individual count prevalence and the interseptal area count prevalence. Thus, with the purpose to facilitate the statistical analysis as well as the presentation and interpretation of the results, the four (2 to 5) categories of the Kerr (1988) system were reduced to two groups, and the findings were categorised as: healthy (category 1), gingivitis (category 2) and periodontitis (categories 3, 4 and 5) (Oztunc *et al.* 2006). In addition, the mean proportion of intereseptal areas with textural changes falling into each one of the four Kerr (1988) categories, i.e. gingivitis (category 2), acute burst of periodontitis (category 3), quiescent phase of periodontitis (category 4) and progressive periodontitis (category 5), was also estimated and taken into account when interpreting the results. The approach of measuring periodontitis prevalence out of the total number of interseptal areas was followed in order to avoid differential preservation bias and variation of interseptal areas to periodontal disease susceptibility.

4.9 Dental Defects of Enamel

4.9.1 How dental enamel defects meet the aims of the present study

Dental enamel defects were selected for two reasons; the first one concerns its significance as an indicator of general health. Enamel hypoplasia is a non-specific marker of growth disruption and has been associated with a large number of possible conditions disrupting the individual’s homeostasis, through metabolic strain originating synergistically by disease and malnutrition (Mendez Colli *et al.* 2008). Thus, it is recognised as an important indicator of general health during growth (Hillson 1996). Events leading to physiological disruption, i.e. malnutrition and disease, are very much affected by socioeconomic conditions and, conversely, socioeconomic conditions may be reflected in the prevalence and distribution of the defects between the ancient and the modern population, as well as within the populations, i.e. between females and males, and between low and high socioeconomic status groups.

The second reason for selecting enamel defects was that they give rise to different potential sites of caries initiation and a different pattern of lesion development (Hong *et al.* 2009). The bands of defective enamel form a line of weakness, along which, enamel can be preferentially demineralised, and, therefore, they predispose to caries (Mellanby 1927; 1929; 1930; 1934; 1941 cited by Hillson 2001, 265). Defective enamel sites may provide a suitable local environment for adhesion and colonisation of cariogenic bacteria, and bacteria may retain at the base of the defect in contact with exposed dentine, thus caries on these defective sites may develop more rapidly (Li *et al.* 1996). Defective enamel has higher acid solubility than normal enamel and is more susceptible to caries attack (Zheng *et al.* 1998). The association between enamel hypoplasia has been reported in several cross-sectional (Milgrom *et al.* 2000; Montero *et al.* 2003; Daneshkazemi & Davari 2005) and longitudinal studies (Lai *et al.* 1997; Oliveira 2006). Therefore, it was felt appropriate to record enamel hypoplasia also in order to explore its relationship with dental caries.

4.9.2 Method for recording dental enamel defects

All teeth were examined initially with the naked eye, and secondarily, with the aid of a 10x power hand lens. All observations were made in a consistent manner, with diffuse background light, both natural and fluorescent, with a bright secondary light source set at an oblique angle (Lukacs *et al.* 2001). Loose teeth and teeth in occlusion were rotated through a variety of angles to highlight areas of deficient and missing enamel (Halcrow & Tayles 2008; Lukacs *et al.* 2001).

To qualify as enamel hypoplasia, defects were matched between at least two different tooth classes, e.g. incisor and canine, in the same individual. This ensured that the observed disruption was the result of systemic physiologic disruption rather than localised trauma (King *et al.* 2005). However, in cases were only a single tooth or tooth class was present and affected, and the rest of the teeth or tooth classes were missing, then the defects were recorded. This was done to avoid enamel hypoplasia prevalence underestimation resulting from poor preservation. It is recognised that this method of scoring might minimally overestimate the actual number of affected individuals with enamel defects as a result of systemic disturbance, as some of the lesions recorded might have been caused by localised trauma (Brook 2009). However, cases of individuals with only one tooth or tooth class present and affected were rare. In addition, studies have shown that, although enamel defects are the result of three potential causes, including hereditary anomalies, localised trauma and systemic metabolic stress (Goodman & Rose 1991), those arising as hereditary anomalies or as localised trauma are rare in human populations (Larsen 1997, 45), whereas the vast majority are linked to systemic physiological disruption (Goodman & Rose 1990; Hillson & Bond 1997).

Because expression may vary between the left and the right sides and between the upper and the lower dentition, both left and right teeth, as well as both upper and lower teeth of each tooth type were examined for enamel hypoplastic defect occurrence (Griffin & Donlon 2009; Palubeckaite *et al.* 2000 cited by Paubeckaite *et al.* 2002). All tooth types were included in the study but because of the fact that anterior teeth are more susceptible to enamel hypoplasia (Boldsen 2005; Cucina 2002; Goodman & Armelagos 1985) and the defects are more clearly visible on them, comparisons between population samples and sub-samples were made seperately for each tooth class, in order to avoid differential preservation bias.

The *severity* of hypoplasia was not recorded because severity in the expression of the hypoplastic defect is not proportionate to the severity of the episode that resulted in the defect. It has been argued that the appearance of the defect depends on tooth crown geometry and the same level of growth disruption can result in a different hypoplasia according to an affected tooth and an affected part of tooth (Hillson & Bond 1997). Furthermore, in the case of plane-form defects, for instance, the width of the band may bear no relationship to the duration of the episode and even wide bands probably represent very short disruptions (Ogden *et al.* 2007). Ideally, in order to measure severity, the method of perikymata groove spacing count proposed by Hillson and Bond (1997) should be used, but, such methods require detailed histological studies that are hardly applicable to large samples (Palubeckaite *et al.* 2002). Histological techniques such as counting the cross striations within the enamel could not be applied also because they require invasive sectioning of the teeth, which was not allowed. It should also be noted that all defects were considered, regardless of their severity.

Dental enamel defects were scored in three different areas of the tooth, namely (a) the *occlusal region*, above the contact area, (b) the *contact area* and (c) the part of the tooth *below the contact area* or involving the *cervical crown*. In cases where the tooth region was present and enamel surface was not smooth, that is to say that defects were observed, enamel hypoplasia was classified into one of the three following categories:

- furrow-like defects.
- band of pitted defects.
- plane-form defects.

Furrow-like defects are defined as grooves on the enamel surface and they tend to run horizontally, parallel to the cement-enamel junction (Griffin & Donlon 2009, 94). The *occlusal type* defects are the classic perikymata form and they consist of broad, shallow waves. The furrow-like defects of the *mid-crown* or contact area are also wave-like but they have a relatively sharp line in each of the grooves between the waves. The *cervical type* defects are the classic imbrication form and the lines in the grooves are much sharper and the ridges in between are much less wave-like (Hillson and Bond 1997, 91). *Pit defects* are well-defined pits in the enamel surface, which may appear as a non-linear array or single, isolated pits; however, due to the fact that single pits have been linked with episodes of localised trauma, in the present study, only *bands of pitted defects*, associated with generalised systemic disruption, were recorded (Griffin & Donlon 2009). Plane-form defects result from the absence of whole sections of enamel of the tooth (Griffin & Donlon 2009).

Initially, the aim was also to estimate the chronological age distribution of the defects. The position of enamel hypoplasia was located by measuring the distances between the grooves' midpoint from the cement-enamel junction as well as the height of the crown of each affected anterior tooth, using a digital Mitutoyo sliding caliper (Colli *et al.* 2009). The distance measurements were to be converted into estimated age of occurrence using the developmental chart presented by Reid and Dean (2000), since no such standards exist for Greek populations, and using as the standard the mean height of the crown of each anterior tooth, which would have been previously calculated from the sample's total of unworn teeth. However, in the archaeological population, the sample of unworn anterior teeth was very small and, for that reason, the chronological age distribution was not estimated (Littleton 2005).

4.9.3 Calculating dental enamel defects frequency

The results of dental enamel defects frequency took three different forms:

(a) the individual count prevalence, which is the percentage of individuals with enamel hypoplasia, that is the number of individuals affected divided by the total number of individuals available for observation.

(b) the tooth count prevalence, which is the percentage of teeth with enamel hypoplasia, that is the number of teeth divided by the total number of teeth observed.

(c) the tooth area count prevalence, which was the percentage of tooth parts, i.e. occlusal, contact and cervical areas, that is the number of tooth areas divided by the total number of observable tooth areas.

The above approach for measuring enamel defect prevalence was followed to avoid differential preservation bias in relation to teeth and tooth regions exhibiting variation in hypoplastic defect susceptibility, size and prominence. For instance, defects are more difficult to identify on molar teeth due to the steep gradient in perikymata spacing on molar crown spacing (King *et al.* 2005, 553) and because of the fact that molar teeth have more appositional enamel and, therefore, a smaller proportion of enamel growth is represented at the crown surface (Hillson & Bond 1997). The tooth count prevalence was estimated because teeth were often not present or observable, due to antemortem or postmortem tooth loss, or tooth surface damage. The tooth area count prevalence was measured for the same reason, since macroscopically visible hypoplasias are more common in the middle and cervical thirds of teeth (Goodman & Rose 1990). This is related to the decreased spacing between perikymata toward the crown cervix, making hypoplastic events more evident in these regions of the crown than near the occlusal edge (King *et al.* 2005). Furthermore, there is differential exposure to wear of different parts of the tooth crown with the occlusal third often obliterated by occlusal attrition (King *et al.* 2005). The frequency of tooth areas affected also served the purpose of establishing the extent of the problem by recording the proportion of the enamel surface area disrupted by hypoplasia (Ogden *et al.* 2007).

All the above were broken down according to tooth class and tooth type, in order to avoid differential preservation bias. Although overall percentages are presented in the *Results Chapter* due to space limitations, frequencies by tooth class and type were also taken into consideration when interpreting the results. More specifically, the following frequencies were taken into account:

(a) overall, i.e. regardless of tooth type, tooth region and type of defect, enamel defect prevalence.

(b) dental defect frequencies, regardless of defect type, for anterior and posterior teeth and for each tooth class/type separately.

(c) enamel defect rates, regardless of tooth type, by tooth region.

(d) percentages of individuals with furrow-like defects and bands of pitted defects separately (plane-form defects were not detected).

(e) percentages of (whole) teeth with furrow-like defects and bands of pitted defects separately (plane-form defects were not detected).

(f) percentages of tooth regions with furrow-like defects and bands of pitted defects separately (plane-form defects were not detected).

4.10 Comparisons, Descriptive Statistics and Statistical Analysis

All analyses were conducted using the Statistical Package for Social Sciences (SPSS 12.0). Descriptive statistics were calculated for all dental pathologies and wear and frequencies (%) of and by the following were calculated:

- for individuals affected.
- for teeth affected.
- by tooth type / intereseptal area.
- by tooth class.
- by tooth surface or area.
- for uppper and lower dentition separately.

The comparisons that were made were the following:

- between burial assemblages, i.e. between Demetrias and Athens.
- between the sexes within burial assemblages, e.g. between females and males in Demetrias.
- between socioeconomic status groups, e.g. between the low and high SES group in Demetrias.
- between the sexes for each one of the socioconomic status groups, e.g. between females of high SES and males of high SES.
- between the socioeconomic status groups for each sex group separately, e.g. between the low SES males and high SES males.
- among the three age classes, i.e. young, middle and older adults, in each population subset, i.e. population, sex, SES group, sex within SES sample, and SES group with sex sample.

The possibility of an association between nominal data, i.e. between population assemblages, sex, age-at-death or social status and the occurrence of each pathological condition and wear was analysed using the χ^2 test for the data on prevalence by tooth and by tooth surface and region, or by interseptal area. Mathematical probability (*p-value*) ranges from *0* to *1*, *zero* meaning no chance and *one* meaning certainty (Howitt & Cramer 2003). *p* values of less than *0.05* were taken to indicate statistical significance, meaning that there is only *5%* probability that the differences observed occured due to chance (Salkind 2000). If *p* was less than *0.001*, the result was considered highly significant. Results that were not statistically significant reflected that they were not strong enough to reject the null hypothesis. In other words, a real difference does not always show statistical significance. Thus, statistical significance is the degree of risk you are willing to take that you will reject a null hypothesis when it is actually true (Salkind 2000, 174). Additionally, there are two other factors that should also be considered; first, the samples tested do not identically represent the profile of the once-living population and secondly, there are other possible sources of difference, which might have been missed or cannot be eliminated (Salkind 2000). Due to the three aforementioned reasons, differences among subgroups were taken into account and were discussed, even if χ^2 tests showed that they were not statistically significant. Statistical significance tests were only employed in order to make a case stronger.

Chapter 5

RESULTS

This chapter presents some of the most fundamental results produced by the data gathered from recording dental caries, antemortem tooth loss, occlusal wear, periodontal disease and enamel defects of enamel, in the Demetrias and Athens burial assemblages. Due to space limitations, it was not possible to include all the results generated. However, all of them were taken into account, including those that are not presented in the thesis, when interpreting the findings of the present research study. Moreover, more detailed results, such as corrected caries rates and enamel defect frequencies in anterior teeth, are included in the *Discussion* (*Chapter 6*), where this was considered necessary in order obtain a more in-depth understanding of the patterns observed in each case. The integration of some of the results, as well their statistical significance, in the discussion rather than the results section, was considered essential to maintain the cohesion of the arguments. For the same reason, comparisons between populations and among the subgroups defined by sex/gender and social status are also discussed in the next chapter.

The findings are presented in the form of percentages and in some cases counts, either in text or summarised in tables and charts. The description of the results is provided for each assemblage and distinct subgroup in a separate section. More specifically, frequencies for caries, antemortem tooth loss (AMTL), wear, periodontal disease and enamel defects are presented for the following groups: (a) Demetrias, regardless of sex and socioeconomic status (SES), (b) Athens, regardless of sex and socioeconomic status (SES), (c) Demetrias-females, (d) Demetrias-males, (e) Athens-females, (f) Athens-males, (g) Demetrias-low SES, (h) Demetrias-high SES, (i) Athens-low SES, (j) Athens-high SES. All the above are also considered for each of the three age classes. All relevant information has already been discussed in the *Methodology* (*Chapter 4*).

Additionally, some points regarding the tables and figures in this chapter need clarification. The term frequency rates refers to the percentage of the total of teeth, tooth sockets, tooth regions or interseptal areas present and observable. Each number in the "Tooth Type" column in the tables and in the axis of the bar charts corresponds to a tooth type: 1=*first incisors*, 2=*second incisors*, 3=*canines*, 4=*first premolars*, 5=*second premolars*, 6=*first molars*, 7=*second molars*, 8=*third molars*. In some of the figures, left, right, upper and lower teeth are all grouped together, whereas in the tables and some of the figures, only left and right teeth are grouped together and results are presented for the upper and the lower dentition separately. In the axis of the bar charts for periodontal disease, interseptal areas, as already noted in the *Methodology* (*Chapter 4*), are named after the two teeth belonging to the tooth sockets adjacent to each interseptal area. The codes for the interesptal areas are the following: 8-7: *third molars-second molars*, 7-6: *second molars-first molars*, 6-5: *first molars-second premolars*, 5-4: *second premolars-first premolars*, 4-3: *first premolars-canines*, 3-2: *canines-second incisors*, 2-1: *second incisors-first incisors* (right quadrants of the upper and lower dentition), 1-1: right *first incisors*-left *first incisors*, 1-2: *first incisors-second incisors*, 2-3: *second incisors-canines*, 3-4: *canines-first premolars*, 4-5: *first premolars-second premolars*, 5-6: *second premolars-first molars*, 6-7: *first molars-second molars*, 7-8: *second molars-third molars* (left quadrants of the upper and lower dentition).

5.1 Dental Caries

Dental caries and antemortem tooth loss are discussed together in the same section. First, the overall and by tooth type percentages of observable tooth sockets, the teeth lost antemortem and postmortem, the teeth with eruption problems, and the teeth observed for carious lesions are presented. Comparisons are made between maxillary and mandibular detition, anterior and posterior teeth, and among tooth types and age groups. Moreover, frequencies of antemortem tooth loss and caries, regardless of lesion position on the tooth, are reported. Both overall rates, i.e. regardless of stage of development, and enamel, dentine, and pulp exposing lesion rates are also presented. Finally, this section includes the prevalence of caries according to lesion position, i.e. occlusal, pit, occlusal attrition facet dentine, contact (mesial and distal), smooth surface (buccal and ligual), and root surface (mesial, distal, buccal and lingual) caries. Detailed information on all the aforementioned can be found in the *Methodology* (*Chapter 4*), in sections 4.6.2 and 4.6.3.

5.1.1 Within populations

5.1.1.1 Demetrias

Teeth examined and missing

The total number of observable tooth sockets was 5,000, of which, 372 (7.4%) teeth were lost antemortem and 723 (14.5%) were lost post-mortem. Eruption problems were observed in 109 (2.2%) teeth, of which 102 never erupted, six were partly erupted, whereas anomalous eruption was observed in one tooth only. Of these, 103 were third molars, 4 second molars and 1 first incisor. Overall, 3,796 teeth were examined for the presence of carious lesions, of which, 3071 (61.4% of the observable tooth sockets and 80.9% of the teeth examined for caries) 725 (7.6% of the teeth examined for caries) were not in occlusion, i.e. loose. The occlusal surfaces of two of the partly erupted third molars were also observable. The percentages of teeth present, lost antemortem or postmortem, and of those with eruption problems, regardless of age, are presented in Table 5.1, and by age group, in Figures 5.1a and 5.1b for upper and lower dentition, respectively.

Tooth Type		Present	Lost AM	Lost PM	Eruption Problems	Total
1	**N**	356	22	211	1	**590**
	%	60.3%	3.7%	35.8%	.2%	**100.0%**
2	**N**	400	20	180	0	**600**
	%	66.7%	3.3%	30.0%	.0%	**100.0%**
3	**N**	550	12	106	1	**669**
	%	82.2%	1.8%	15.8%	.1%	**100.0%**
4	**N**	549	25	72	0	**646**
	%	85.0%	3.9%	11.1%	.0%	**100.0%**
5	**N**	514	66	58	0	**638**
	%	80.6%	10.3%	9.1%	.0%	**100.0%**
6	**N**	522	119	20	0	**661**
	%	79.0%	18.0%	3.0%	.0%	**100.0%**
7	**N**	544	64	24	4	**636**
	%	85.5%	10.1%	3.8%	.6%	**100.0%**
8	**N**	361	44	52	103	**560**
	%	64.5%	7.9%	9.3%	18.4%	**100.0%**
Total	**N**	**3796**	**372**	**723**	**109**	**5000**
	%	**75.9%**	**7.4%**	**14.5%**	**2.2%**	**100%**

Table 5.1: Number and percentages of teeth present, missing antemortem, lost postmortem, and with eruption related problems in each tooth type (upper and lower together), regardless of age, in Demetrias.

In the young adult age group, a total of 80.2% of all teeth was present. This number decreased in the middle adult group (73.8%) and again, slightly increased in the older group (75.5%). AMTL steadily increased from 3.1% in the young individuals to 8.6% in the middle and 12.9% in the older adults. This increase was observed in all tooth types (Figs. 5.1a & 5.1b) but it was more marked in the first molars, with 10.3%, 18.6% and 35.4% of the teeth of young, middle and older individuals accordingly, lost antemortem. The most frequently missing (AMTL) tooth class were molars, and first molars of older adults (35.4%)

in particular, whereas canines were the least frequently missing tooth class, with none of the canines of young adults lost antemortem (0.0%) (Figs. 5.1a & 5.1b). The frequency of teeth lost postmortem was markedly higher in the anterior teeth, especially incisors, in all age groups (Figs. 5.1a & 5.1b). The first incisor was the most frequently missing (PMTL) tooth type (33.1% in the young, 39.9% in the middle, 21.8% in the older), and the first molar the least (1.5% in the young, 4.0% in the middle, 2.5% in the older). Overall, molars, especially first, suffered AMTL much more often but were lost postmortem less frequently than incisors or canines.

When upper and lower dentitions were compared, marked differences were noted. In the young and middle adult groups, the frequency of teeth present was higher in the maxillary dentition, whereas in the older age group, more mandibular teeth survive (Figs. 5.1a & 5.1b). The lower teeth suffered AMTL more frequently than the upper in the young and middle adult groups but less often in the older group. More specifically, the rates of AMTL in all tooth types in the two younger age classes and first and third molars in the older group were higher in the lower dentition; the opposite was the case only in the incisors, canines, premolars and second molars of older individuals (Figs. 5.1a & 5.1b). The greatest difference between upper and lower dentition was observed in the first molars of all age groups but was even more marked in the older adults (Figs. 5.1a & 5.1b). In both the upper and the lower dentition, the most frequently missing (AMTL) of the tooth classes, were the first molars of older individuals, with 26.9% and 39.6% of teeth lost, respectively. Anterior teeth, especially canines, were rarely lost antemortem (Figs. 5.1a & 5.1b). The frequency rates for loss of teeth after death were very similar for maxillary and mandibular teeth in young and older adults; however, in the middle adult group, these were considerably higher for the lower teeth (Figs. 5.1a & 5.1b).

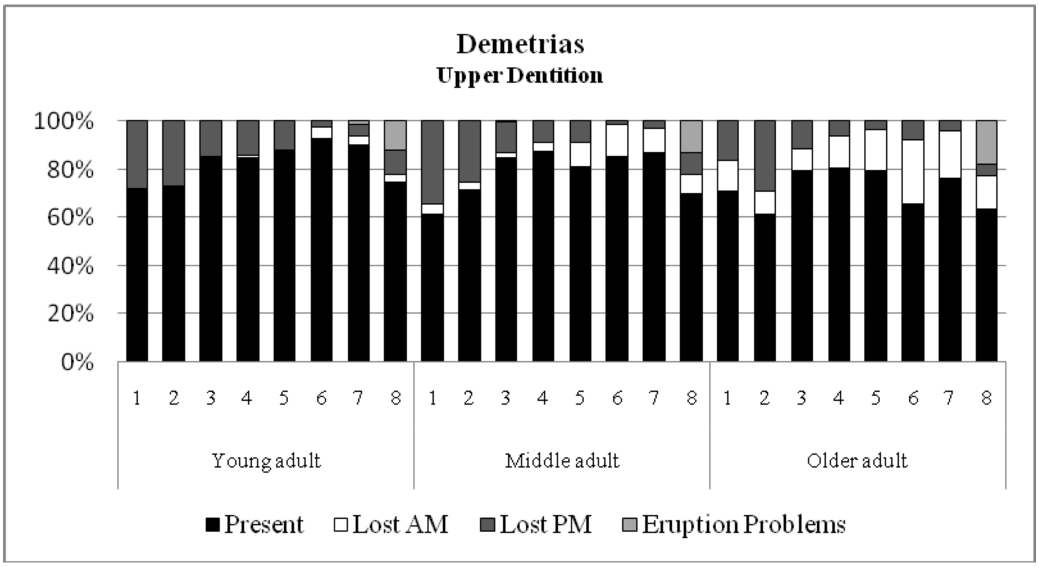

Figure 5.1a: Frequency rates of teeth present, missing antemortem, lost postmortem, and with eruption related problems for each tooth type (upper dentition), and age group, in Demetrias.

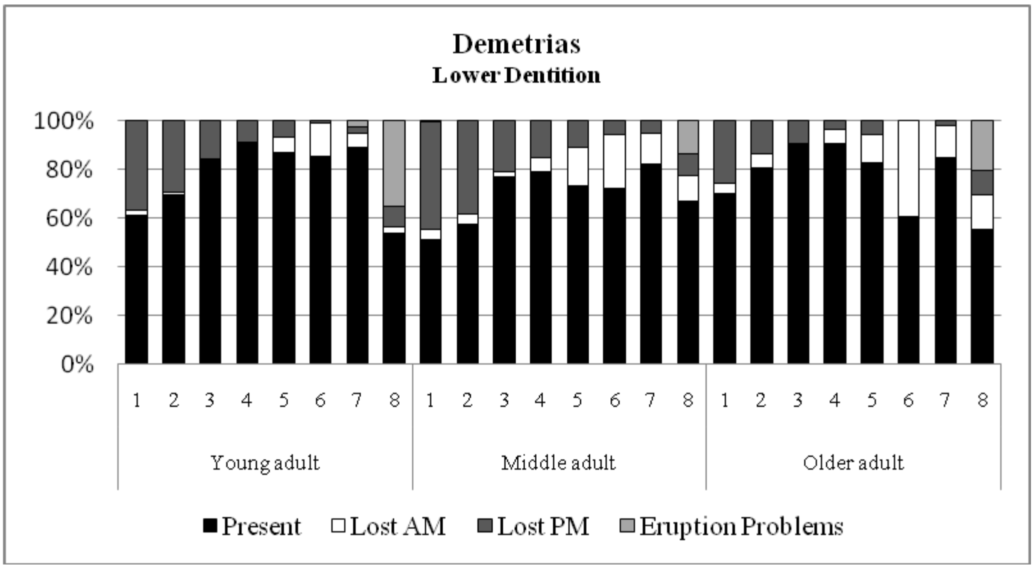

Figure 5.1b: Frequency rates of teeth present, missing antemortem, lost postmortem, and with eruption related problems for each tooth type (lower dentition), and age group, in Demetrias.

Eruption problems were much more common in the lower dentition, mostly in the young age group (Figs. 5.1a & 5.1b). The greatest difference was observed in the young group, with 11.9% and 35.1% of the upper and lower third molars respectively, exhibiting eruption related problems.

Caries

In the whole assemblage from Demetrias, 8.6% (328 / 3796) of the permanent teeth and 45.4% (108 / 238) of individuals with surviving teeth were affected by caries. When only cavitated lesions were considered, these figures decreased to 7.5 % (285 / 3796) and 43.7% (104 / 238) respectively. Of 238 individuals with dentitions, 16 (6.7%) had only one decayed tooth. Gross cavities, in at least one tooth, were observed in 25.2% (60 / 238) of individuals.

In Figures 5.2a, 5.2b and 5.2c, AMTL and caries rates, on any tooth surface and regardless of lesion type, are presented for each tooth by age group. In the younger age group, 6.7% of all teeth were carious. This slightly rose to 7.0% in the middle adults and markedly increased to 20.4% in the older individuals. The rates of AMTL were 3.1% in the young, 8.6% in the middle and 12.9% in the older age group. Therefore, both conditions showed a marked increase with age. In all age groups, caries attacked posterior teeth, especially first molars, more frequently than anterior teeth. The same pattern was evident in AMTL. Carious lesions occured more frequently in the upper (8.9%) than in the lower dentition (8.5%). The most caries- and AMTL- involved teeth (upper and lower together) were first molars, with 13.6% and 18.0% of them affected, respectively. The largest value for caries frequency in a particular tooth type was observed in mandibular first molars (38.2%) and maxillary first molars (35.0%) in older individuals.

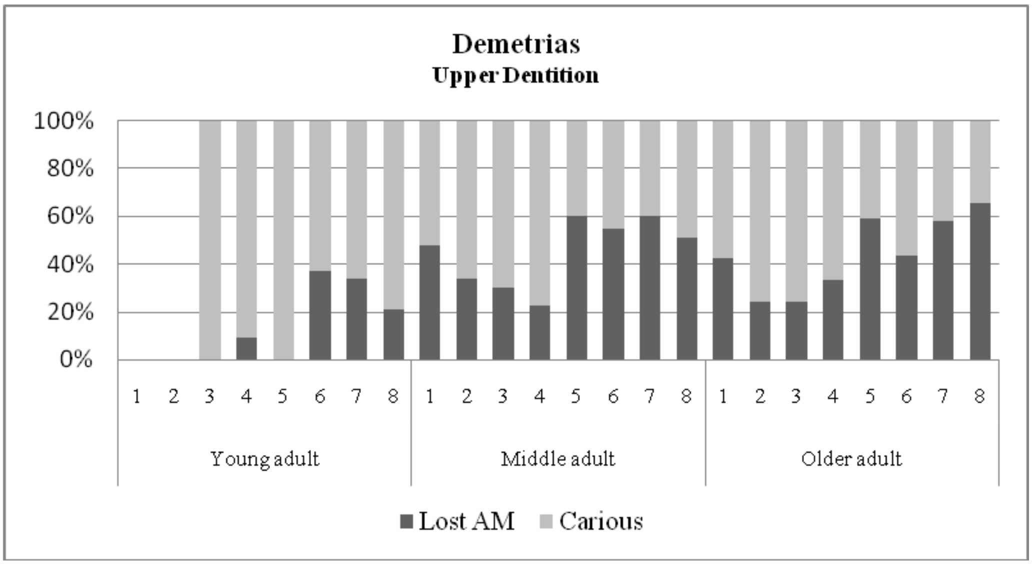

Figure 5.2a: Caries and antemortem tooth loss frequency rates for each tooth type (upper dentition), and age group, in Demetrias.

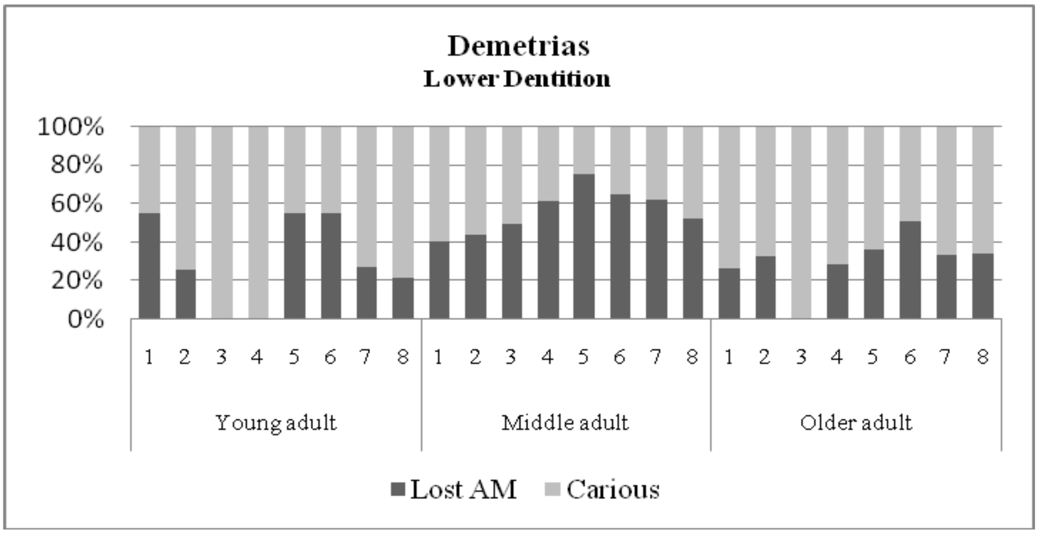

Figure 5.2b: Caries and antemortem tooth loss frequency rates for each tooth type (lower dentition), and age group, in Demetrias.

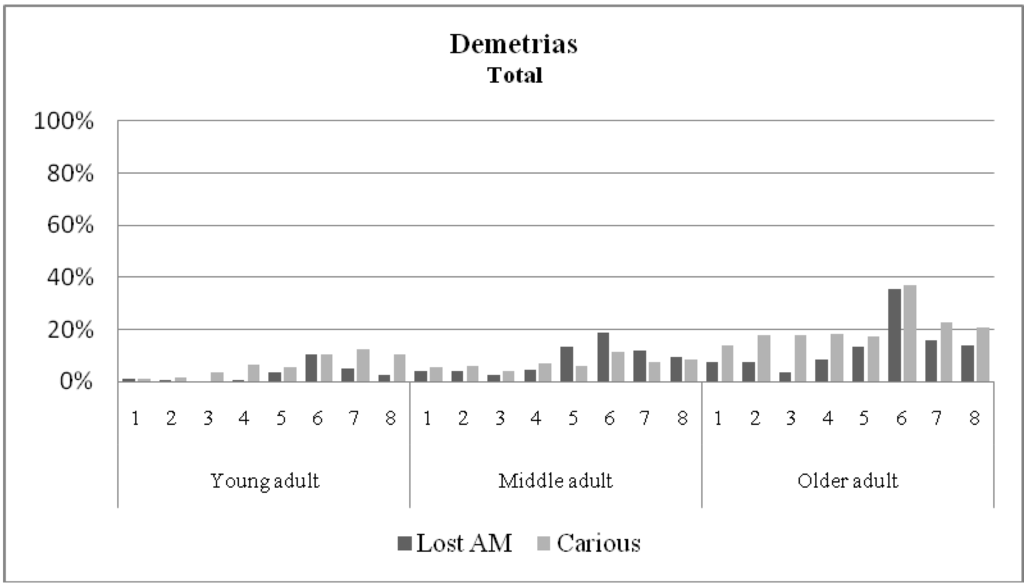

Figure 5.2c: Caries and antemortem tooth loss frequency rates for each tooth type (upper and lower dentition together), and age group, in Demetrias.

First molars were the most frequently affected teeth (13.6%), followed by the second molars (10.9%) and the third molars (10.6%). Caries rates in first premolars (8.3%) were higher than in the second (7.2%) and were followed by second incisors (6.5%) and canines (5.8%), with first incisors being the least affected tooth type (5.4%) in the whole dentition.

In Figures 5.3a and 5.3b, caries frequency rates are presented for each tooth type by age group in Demetrias, according to the severest lesion type on any surface of the tooth. Dentine lesions were the most common form in young adults, followed by lesions penetrating to the pulp chamber, and enamel lesions. In the middle adults, pulp lesion frequencies were slightly higher than those of dentine lesions, whereas enamel caries rates were very low. In the older individuals, lesions penetrating to the dentine were the most common form and enamel lesions the least common (Figs. 5.3a & 5.3b).

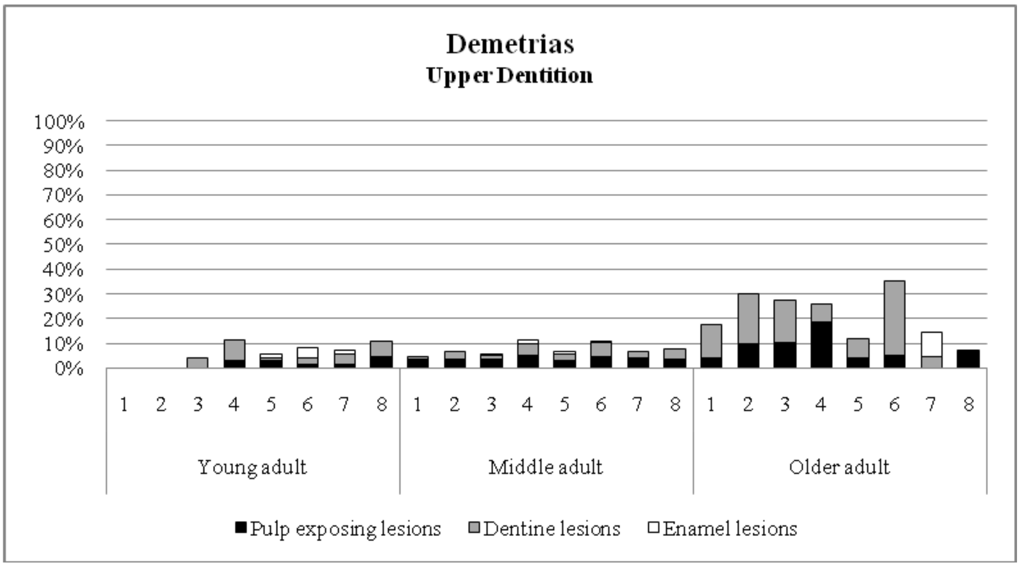

Figure 5.3a: Caries frequency rates for each tooth type (upper dentition), by age group, according to the severest lesion type on any surface of the tooth, in Demetrias.

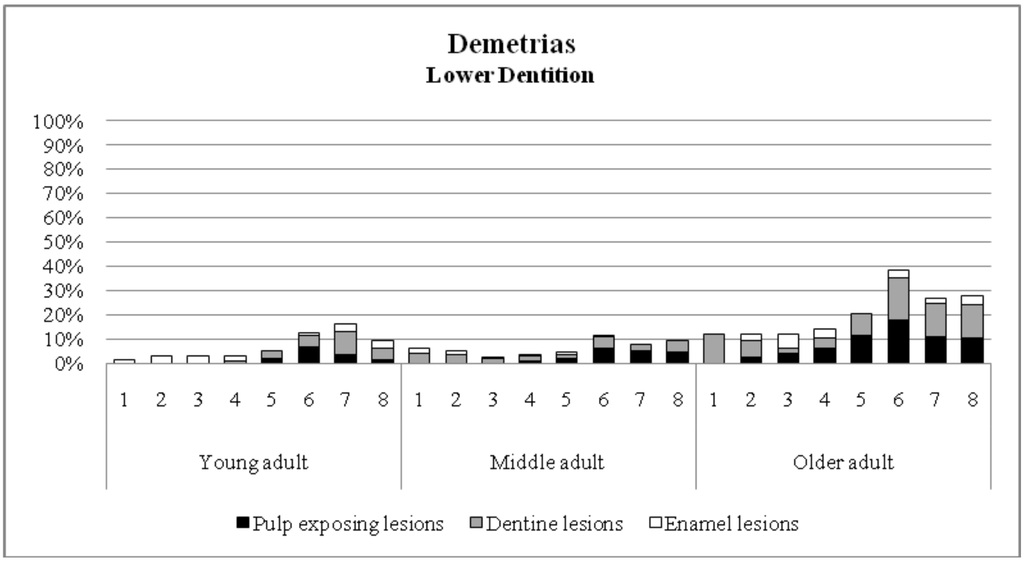

Figure 5.3b: Caries frequency rates for each tooth type (lower dentition), by age group, according to the severest lesion type on any surface of the tooth, in Demetrias.

Enamel lesions were rare in all age groups with the oldest being the most frequently affected by this type and the middle the least affected. Pulp exposing lesion rates markedly increased with age. Dentine lesions were three times more common in the older adults than in the other two age groups, but young individuals showed a slightly higher frequency of this form than the middle adults (Figs. 5.3a & 5.3b).

Overall, pulp and dentine lesions predominated in the posterior teeth, particularly molars. Enamel lesions, although they were frequent in the posterior teeth of the young and older adults, constituted the type that predominated in the anterior teeth (Figs. 5.3a & 5.3b). If upper and lower dentitions are compared, pulp and dentine lesions rates are higher in the former, whereas lesions confined to the enamel are more common in mandibular teeth (Figs. 5.3a & 5.3b).

When lesion types were considered individually, pulp exposing lesions were observed more often in molars than in premolars and incisors/canines (Figs. 5.3a & 5.3b). The same was the case for lesions penetrating to the dentine, but with premolars and incisors equally affected by this type. The pattern for enamel lesions however, was quite different; they predominated in canines and equally affected molars and incisors, as well as first premolars (Figs. 5.3a & 5.3b). Very similar were the patterns when frequency rates were observed separately in each age group. Lesions penetrating to the pulp chamber and the dentine were predominant in both premolars and molars of young adults, and molars of middle and older individuals. In the older group, lesions penetrating to the dentine were very common in the incisors. Enamel caries frequencies in the incisors and canines in all age groups were very high, when compared to those of other lesion types (Figs. 5.3a & 5.3b). Overall, in the middle and older groups, maxillary teeth were carious more often than mandibular teeth, whereas, in young individuals, the opposite was the case (Figs. 5.3a & 5.3b). More specifically, pulp lesions more frequently affected the upper dentition of middle and older adults, and the lower dentition of young adults. Dentine lesions were more common in the upper teeth of young and older individuals, and equally affected maxillary and mandibular teeth of middle individuals. Finally, enamel lesions were more common in the mandibular dentition of all three age classes (Figs. 5.3a & 5.3b).

Occlusal caries

Of all occlusal surfaces examined, 4.2% (101 / 2433) showed evidence of occlusal caries. Molars were markedly more affected (5.1%, 4.9%, 4.8% for first, second and third molars, respectively) than premolars (3.0% and 3.2% for first and second premolars, respectively). The teeth most affected were first molars and the teeth least affected were first premolars. The rates of occlusal surface caries were higher in the lower (4.4%) than the upper (3.9%) teeth and increased steadily through the age groups from 2.9% in young adults, to 4.1% in middle and 8.1% in older individuals.

Pit caries

The frequency of pit caries (4.1% - 69 / 1693) was slightly lower than that of occlusal surface caries. The percentages were higher for molars (4.2%, 4.2% and 4.5% for first, second and third molars, respectively) than incisors (2.7% and 3.8% for first and second incisors). Third molars were the most affected tooth type and first incisors the least affected. The rates were higher in lower (5.7%, 4.9% and 5.0% for first, second and third molars, respectively) than upper (1.9%, 3.0% and 3.6% for first, second and third molars, respectively) molars and increased steadily through the first two age groups from 3.3% in young to 4.5% in middle adults but decreased to 4.3% in older individuals.

Occlusal attrition facet dentine caries

Of all occlusal attrition facets examined, 4.3% (162 / 3612) showed evidence of occlusal attrition facet dentine caries. First molars were the most frequently affected tooth type (7.5%) and canines the least (2.0%). All other posterior and anterior tooth types' rates, except for third molars (3.1%) were very similar, ranging from 4.2% to 4.4%. The percentages were higher in the upper (4.5%) than the lower (4.2%) dentition and markedly increased with age, from 1.9% in young adults to 4.2% in the middle and 10.6% in the older individuals.

Contact Caries

Of all contact areas between neighbouring teeth (mesial and distal) examined, 3.3% (245 / 7359) showed evidence of contact caries. First molars were the most frequently affected tooth type (4.9%) and canines the least (1.9%). In general, posterior teeth were most frequently affected. The percentages were slightly higher in the upper (3.4%) than the lower (3.3%) dentition and markedly increased with age, from 1.3% in young adults to 3.4% in the middle and 7.6% in the older individuals.

Smooth surface caries

Of all smooth surfaces (buccal and lingual) examined, 2.5% (189 / 7471) showed evidence of smooth surface caries. Second incisors were the most frequently affected tooth type (3.5%) and canines the least (1.3%). Anterior teeth, except for canines, were more frequently affected than posterior. The percentages were higher in the lower (2.8%) than the upper (2.2%) dentition and markedly increased with age, from 0.7% in young adults to 2.6% in the middle and 6.8% in the older individuals.

Root surface caries

Of all root surfaces (mesial, distal, buccal and lingual) examined, 3.5% (518 / 14855) showed evidence of root surface caries. First molars were the most frequently affected tooth type (4.9%) and canines the least (2.3%). Posterior teeth were more frequently affected than anterior. The percentages were higher in the lower (4.0%) than the upper (2.8%) dentition and markedly increased with age, from 2.1% in young adults to 3.2% in the middle and 8.3% in the oldest group.

5.1.1.2 Athens

Teeth examined and missing

The total number of observable tooth sockets was 6,368, of which 3331 (52.3 %) were lost antemortem and 1641 (25.8 %) were lost post-mortem. Eruption problems were observed in 110 (1.7 %) teeth, of which 95 never erupted, 9 were partly erupted, whereas anomalous eruption was observed in 6 teeth. Of these, 105 were third molars, 2 second molars and 3 second incisors. In addition, 12 teeth (0.2%) were unobservable. Overall, 1274 (20.0% of observable sockets) teeth were examined for the presence of carious lesions. The percentages of teeth present, lost antemortem or postmortem, and of those with eruption problems, regardless of age, are presented in Table 5.2, and by age group, in Figures 5.4a and 5.4b, for upper and lower dentition, respectively.

Tooth Type		Present	Lost AM	Lost PM	Unobser vable	Eruption Problems	Total
1	**N**	94	324	372	2	0	**792**
	%	11.9%	40.9%	47.0%	.3%	.0%	**100.0%**
2	**N**	122	332	335	3	0	**792**
	%	15.4%	41.9%	42.3%	.4%	.0%	**100.0%**
3	**N**	181	317	296	2	0	**796**
	%	22.7%	39.8%	37.2%	.3%	.0%	**100.0%**
4	**N**	164	422	212	1	0	**799**
	%	20.5%	52.8%	26.5%	.1%	.0%	**100.0%**
5	**N**	138	458	199	0	3	**798**
	%	17.3%	57.4%	24.9%	.0%	.4%	**100.0%**
6	**N**	199	531	68	0	0	**798**
	%	24.9%	66.5%	8.5%	.0%	.0%	**100.0%**
7	**N**	237	477	82	0	2	**798**
	N	29.7%	59.8%	10.3%	.0%	.3%	**100.0%**
8	**%**	139	470	77	4	105	**795**
	N	17.5%	59.1%	9.7%	.5%	13.2%	**100.0%**
Total	**N**	1274	3331	1641	12	110	**6368**
	%	20.0%	52.3%	25.8%	.2%	1.7%	**100.0%**

Table 5.2: Number and percentages of teeth present, missing antemortem, lost postmortem, and with eruption related problems in each tooth type (upper and lower together), regardless of age, in Athens.

In the young adult age group, a total of 50.0% of all teeth was present. This number markedly decreased in the middle (24.7%) and the older adult group (8.5%). AMTL steadily increased from 9.1% in the young individuals to 35.6% in the middle and 76.2% in the older adults. This pattern was observed in all tooth types (Figs. 5.4a & 5.4b) but it was more marked in the second molars, with 9.9%, 45.4% and 84.2% of the teeth of young, middle and older individuals accordingly, lost antemortem. The most frequently missing (AMTL) tooth class were first molars, and first molars of older individuals in particular, whereas canines were the least frequently missing tooth class (Figs. 5.4a & 5.4b). The frequency of teeth lost postmortem was higher in the anterior teeth, especially incisors, in all age groups (Figs. 5.4a & 5.4b). The first incisor was the most

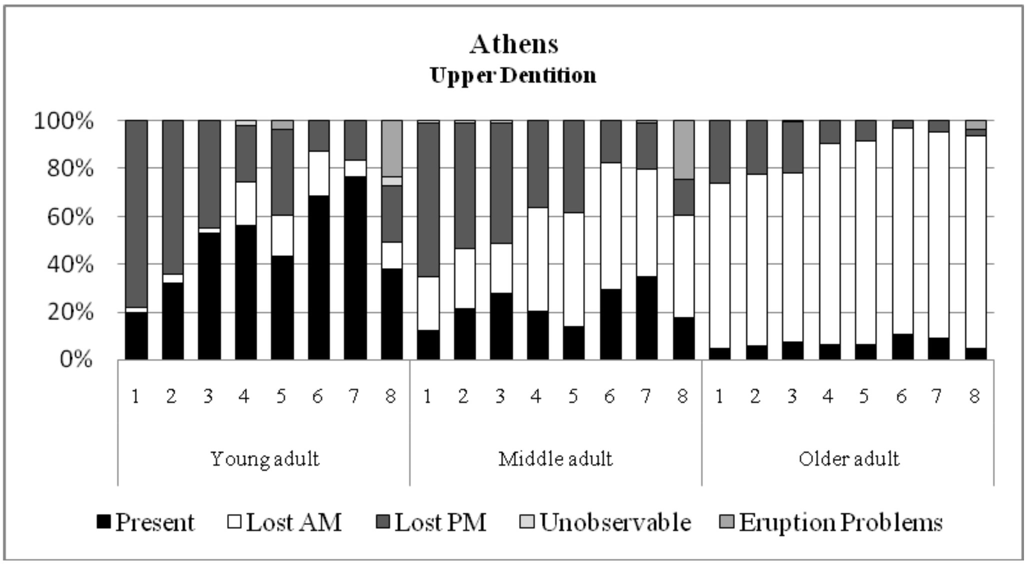

Figure 5.4a: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (upper dentition), and age group, in Athens.

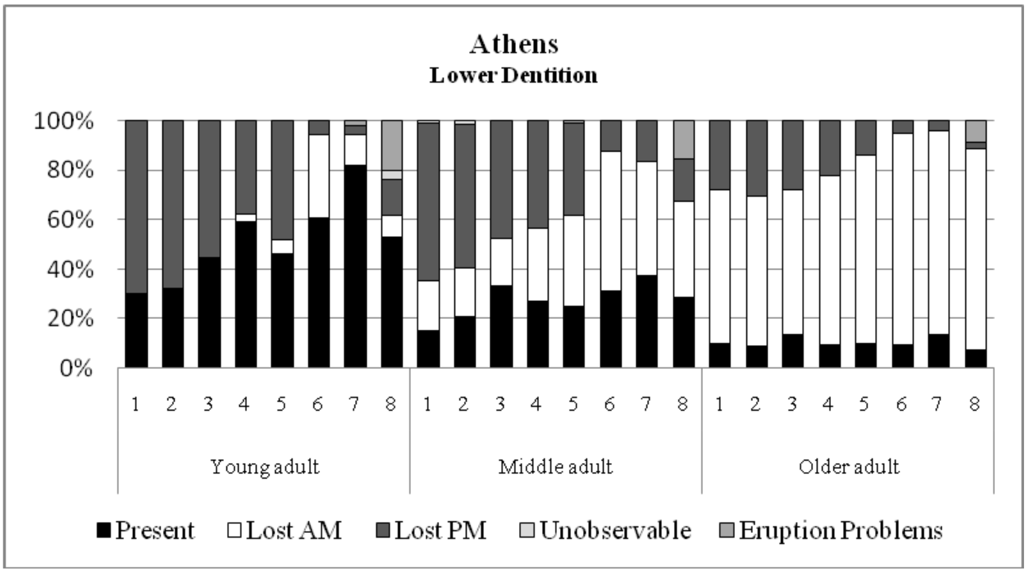

Figure 5.4b: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (lower dentition), and age group, in Athens.

frequently missing (PMTL) tooth type (73.6% in the young, 64.3% in the middle and 27.1% in the older), and the first molar the least (9.1% in the young, 14.8% in the middle and 4.0% in the older). Overall, molars, especially first, suffered AMTL much more often but were lost postmortem less frequently than incisors and canines.

When upper and lower dentitions were compared, marked differences were observed. The frequency of teeth present was higher in the lower dentition in all three age groups (Figs. 5.4a & 5.4b). Maxillary teeth suffered AMTL more frequently than mandibular teeth in all age classes. This was the case for all tooth types and ages; the only exception was first and second molars in young and middle adults. The most frequently missing (AMTL) of the tooth classes, were the third molars in the upper dentition (88.9%) and the first molars in the lower dentition (85.3%), both in the older-adult age group. The rates of AMTL in anterior teeth, though considerably lower than in the posterior, were very high, especially in the older individuals, with 65.7% of first incisors, 66.7% of second incisors, and 64.6% of canines lost before death (Figs. 5.4a & 5.4b). The frequencies of teeth lost postmortem were very similar for maxillary and mandibular teeth in young and middle adults, but considerably higher for lower teeth in the older individuals (Figs. 5.4a & 5.4b). Eruption problems were much more common in the maxillary dentition of young and middle adults, but slightly more frequent in the mandibular teeth of older individuals (Figs. 5.4a & 5.4b). The greatest difference was observed in the young group, with 24.6% and 15.6% of the upper and lower third molars respectively, exhibiting eruption related problems.

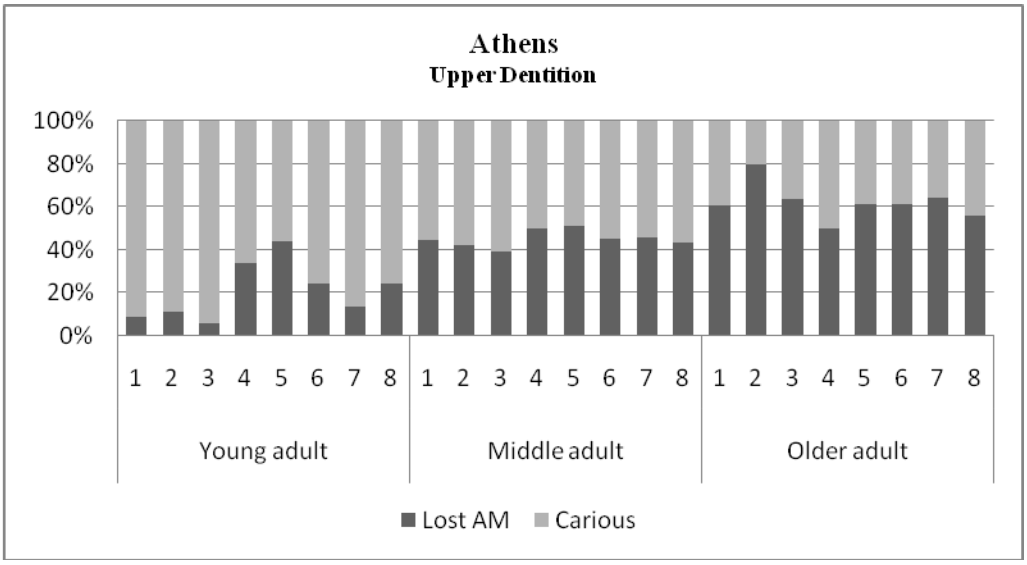

Figure 5.5a: Caries and antemortem tooth loss frequency rates for each tooth type (upper dentition), by age group, in Athens.

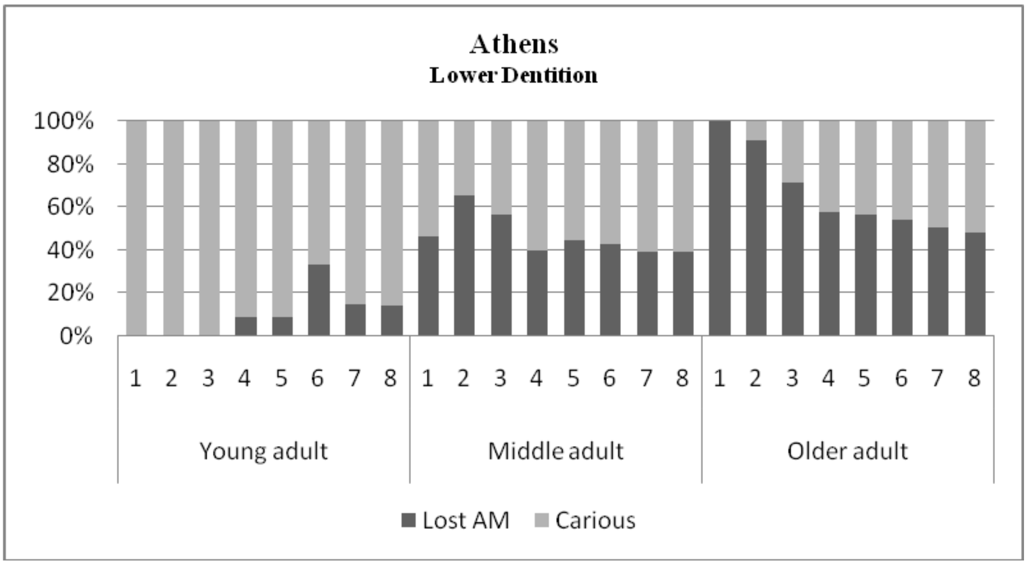

Figure 5.5b: Caries and antemortem tooth loss frequency rates for each tooth type (lower dentition), by age group, in Athens.

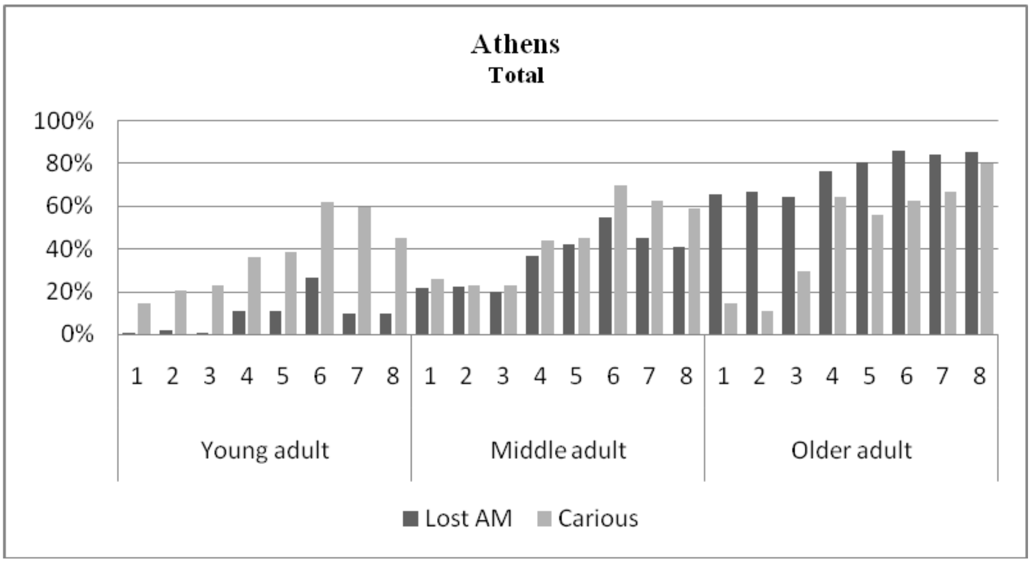

Figure 5.5c: Caries and antemortem tooth loss frequency rates for each tooth type (upper and lower dentiiton together), by age group, in Athens.

<u>Caries</u>

In the whole assemblage from Athens, 45.8% (585 / 1277) of permanent teeth and 91.1% (113 / 124) of individuals with surviving teeth were affected by caries. When only cavitated lesions were considered, the first figure slightly decreased to 42.8% (546 / 1276) but the second remained exactly the same (91.1% - 113 / 124), which means that all the individuals affected by caries also had at least one cavitated lesion. Gross cavities, in at least one tooth, were observed in 42.7% (53 / 124) of individuals.

In Figures 5.5a, 5.5b and 5.5c, AMTL and caries rates, on any tooth surface and regardless of lesion type, are presented for each tooth by age group. In the young adult age group, 42.2% of all teeth were carious; this increased to 46.4% in the middle adult group, and rose to a maximum of 48.9% in the older individuals. The rates of AMTL were 9.1% in the young, and markedly increased to 35.6% in the middle and 76.2% in the older age group. In all age groups, caries attacked posterior teeth, especially first molars, more frequently than anterior teeth. The same pattern was observed for AMTL. Carious lesions occured more frequently in the lower (46.6%) than the upper dentition (44.8%). The most caries- and AMTL- involved teeth (upper and lower together) were first molars, with 60.2% and 66.5% of them affected, respectively. The largest value for caries frequency in a particular tooth type was observed in mandibular third molars (86.7%) and maxillary first premolars (84.6%) in older individuals.

First molars were the most frequently affected teeth (65.8%), followed by the second molars (62.4%) and the third molars (57.7%). Caries rates in second premolars (46.4%) were higher than in the first (45.4%) and were followed by canines (24.3%) and second incisors (19.5%), with first incisors being the least affected tooth type (19.1%) in the whole dentition. In Figures 5.6a and 5.6b, caries frequency rates are presented for each tooth type by age group in Athens, according to the severest lesion type on any surface of the tooth. Dentine lesions were the most common form in young and middle adults, followed by lesions penetrating the pulp chamber, and enamel lesions. The teeth of older individuals, pulp exposing lesions were the most common form and enamel lesions the least common. Fillings were less common than dentine lesions in the young age group but much more common than both dentine and pulp lesions, in the middle and older age groups. Enamel lesions were rare in all age groups with the youngest being the most frequently affected by this type and the middle the least affected. Pulp exposing lesions rates were markedly higher in the older individuals, followed by the young and the middle adults. Dentine lesion frequencies decreased with age. Middle adults exhibited the highest rates of fillings, followed by the older and young individuals (Figs. 5.6a & 5.6b).

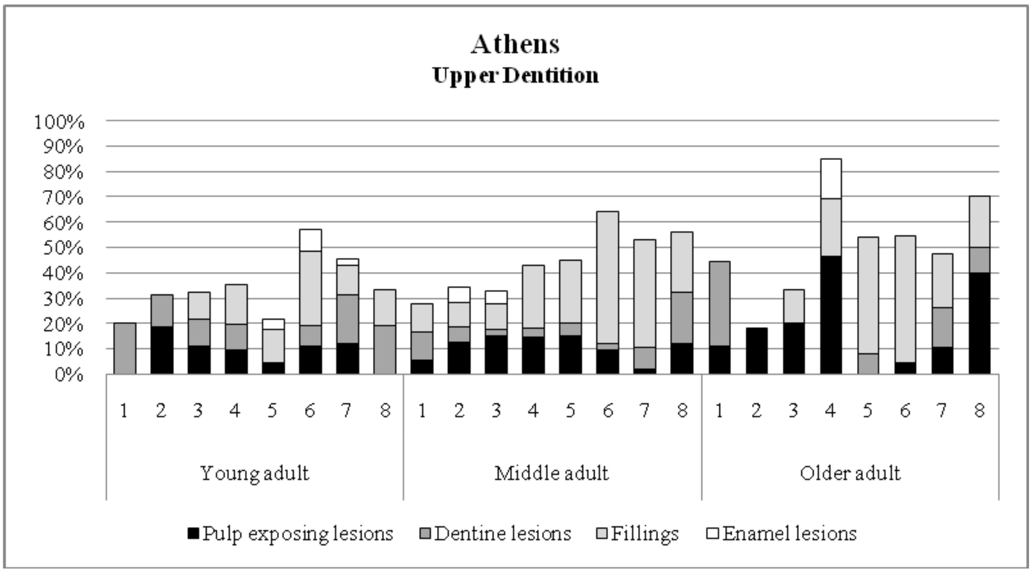

Figure 5.6a: Caries frequency rates for each tooth type (upper dentition), by age group, according to the severest lesion type on any surface of the tooth, in Athens.

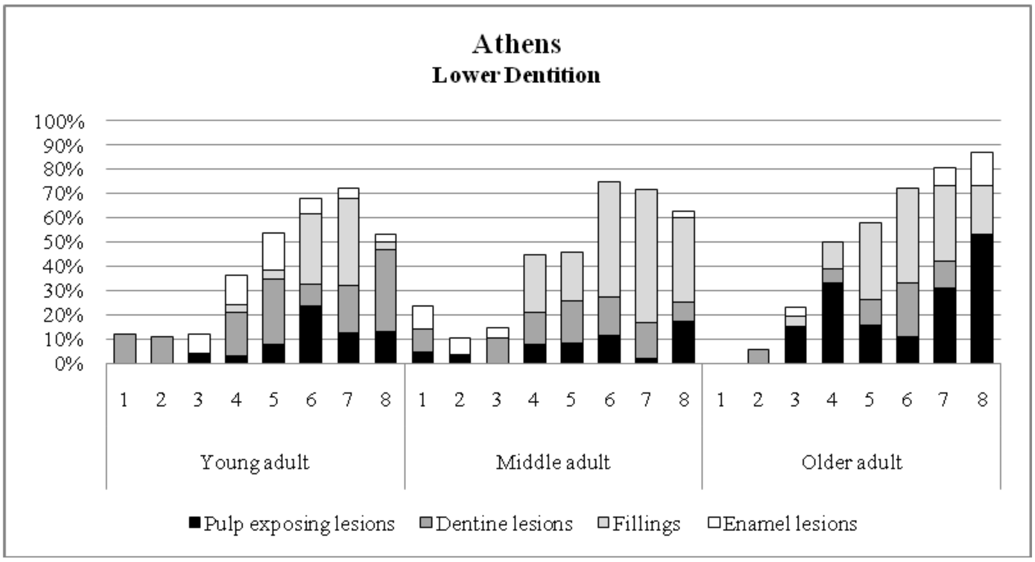

Figure 5.6b: Caries frequency rates for each tooth type (lower dentition), by age group, according to the severest lesion type on any surface of the tooth, in Athens.

Overall, pulp exposing lesions and fillings predominated in the posterior teeth, particularly molars. Enamel lesions were more frequent in the posterior teeth of young and older individuals and the anterior teeth of middle adults (Figs. 5.6a & 5.6b). If upper and lower dentitions are compared, pulp exposing lesions and fillings are higher in the former, whereas dentine and enamel lesions are more common in mandibular teeth (Figs. 5.6a & 5.6b).

When lesion types were considered individually, pulp and dentine lesions, and fillings were observed more often in molars than premolars and incisors/canines. Lesions confined to the enamel however, predominated in the premolars, canines and second incisors and almost equally affected molars and first incisors (Figs. 5.6a & 5.6b). Very similar were the patterns when frequency rates were observed separately in each age group. Lesions penetrating to the pulp chamber were predominant in the molars of young adults and premolars and molars of middle and older individuals. Dentine caries were very common in incisors and molars and incisors were almost equally affected by this type in all age classes. Fillings rates were markedly higher in molars in all age groups, followed by premolars, canines and incisors. Lesions confined to the enamel in young individuals predominated in premolars followed by molars and canines. In middle adults, enamel lesions affected incisors and canines more frequently than any other tooth type, whereas in the older age group, premolars and molars suffered the highest rates of this form of caries (Figs. 5.6a & 5.6b). When upper and lower dentitions were compared, pulp lesions more frequently affected mandibular teeth in the young and older groups and maxillary teeth in the middle adult group. Dentine lesions were more common in the mandibular dentition in the first two age classes and almost equally affected upper and lower teeth in older individuals. Fillings rates were higher in maxillary teeth in all age groups, whereas the exact opposite was the case for lesions of the enamel (Figs. 5.6a & 5.6b).

Occlusal caries

Of all occlusal surfaces examined, 43.9% (369 / 841) showed evidence of occlusal caries. Molars were markedly more affected (58.2%, 50.2%, 48.6% for first, second and third molars, respectively) than premolars (23.2% and 29.6% for first and second premolars, respectively). The teeth most affected were first molars and the teeth least affected were first premolars. The rates of occlusal surface caries were higher in the lower (46.0%) than the upper (41.4%) teeth and increased steadily through the first two age groups from 38.5% in young to 47.3% in middle adults but decreased to 44.3% in older individuals.

Pit caries

The frequency of pit caries (46.9% - 305 / 651) was higher than that of occlusal surface caries. The percentages were markedly higher for molars (54.4%, 51.3% and 45.7% for first, second and third molars, respectively) than incisors (18.2% and 20.8% for first and second incisors). First molars were the most affected tooth type and first incisors the least affected. The rates were higher in the lower (56.4%, 59.0% and 51.2% for first, second and third molars, respectively) than the upper (52.5%, 42.6% and 37.5% for first, second and third molars, respectively) molars and increased steadily through the first two age groups from 44.4% in young to 50.3% in middle adults but decreased to 42.2% in older individuals.

Occlusal attrition facet dentine caries

Of all occlusal attrition facets examined, 23.3% (287 / 943) showed evidence of occlusal attrition facet dentine caries. First molars were the most frequently affected tooth type (43.4%) and first incisors the least (3.3%). Posterior teeth were notably more frequently attacked by caries in the attrition facet, with percentages ranging from 19.4% to 43.4%, whereas only 3.3% 6.0% and 11.0% of first and second incisors, and canines were affected. The percentages were higher in the upper (25.4%) than the lower (21.6%) dentition and steadily increased with age, from 17.4% in young adults to 24.1% in the middle and 29.2% in the older individuals.

Contact caries

Of all contact areas between neighbouring teeth (mesial and distal) examined, 23.1% (581 / 2515) showed evidence of contact caries. First molars were the most frequently affected tooth type (27.3%) and first incisors the least (4.3%). In general, posterior teeth were most frequently affected. The percentages were slightly higher in the upper (23.4%) than the lower (22.9%) dentition. In young adults, the frequency of contact caries was 21.3%; this slightly decreased to 21.1% in the middle individuals and rose again to 28.1% in the oldest group.

Smooth surface caries

Of all smooth surfaces (buccal and lingual) examined, 15.1% (384 / 2539) showed evidence of smooth surface caries. First molars were the most frequently affected tooth type (24.1%) and first incisors the least (4.8%). Posterior teeth were more frequently affected than anterior. The percentages were higher in the lower

(15.9%) than the upper (14.1%) dentition and increased with age, from 12.9% in the youngest group to 13.2% in the middle and 21.8% in the older individuals.

Root surface caries

Of all root surfaces (mesial, distal, buccal and lingual) examined, 9.0% (454 / 5052) showed evidence of root surface caries. First molars were the most frequently affected tooth type (12.2%) and first incisors the least (3.2%). Posterior teeth were more frequently affected than anterior. The percentages were higher in the lower (9.2%) than the upper (8.8%) dentition and markedly increased with age, from 6.2% in young adults to 8.2% in the middle and 14.6% in the oldest group.

5.1.2 Within sexes

5.1.2.1 Demetrias

5.1.2.1.1 Females

Teeth examined and missing

The total number of observable tooth sockets for females in Demetrias was 2,164, of which, 173 (8.0%) teeth were lost antemortem and 345 (15.9%) were lost postmortem. Eruption problems were observed in 63 (2.9%) teeth. Overall, 1,583 (73.2% of observable tooth sockets) teeth were examined for the presence of carious lesions. The percentages of teeth present, lost antemortem or postmortem, and of those with eruption problems, regardless of age, are presented in Table 5.3a, and by age group, in Figures 5.7a and 5.7b, for upper and lower dentition, respectively. In the youngest age group, a total of 79.5% of all teeth was present. This number decreased in middle adults (68.7%) and again

Tooth Type		Present	Lost AM	Lost PM	Eruption Problems	Total
1	N	150	12	98	1	**261**
	%	57.5%	4.6%	37.5%	.4%	**100.0%**
2	N	174	10	79	0	**263**
	%	66.2%	3.8%	30.0%	.0%	**100.0%**
3	N	229	7	54	1	**291**
	%	78.7%	2.4%	18.6%	.3%	**100.0%**
4	N	227	12	39	0	**278**
	%	81.7%	4.3%	14.0%	.0%	**100.0%**
5	N	210	30	28	0	**268**
	%	78.4%	11.2%	10.4%	.0%	**100.0%**
6	N	221	53	12	0	**286**
	%	77.3%	18.5%	4.2%	.0%	**100.0%**
7	N	228	31	13	4	**276**
	%	82.6%	11.2%	4.7%	1.4%	**100.0%**
8	N	144	18	22	57	**241**
	%	59.8%	7.5%	9.1%	23.7%	**100.0%**
Total	N	**1583**	**173**	**345**	**63**	**2164**
	%	**73.2%**	**8.0%**	**15.9%**	**2.9%**	**100.0%**

Table 5.3a: Number and percentages of teeth present, missing antemortem, lost postmortem, and with eruption related problems in each tooth type (upper and lower together), regardless of age, in females from Demetrias.

increased in older individuals (75.3%). AMTL steadily increased from 3.5% in young adults to 10.7% in the middle and 11.6% in the older age group. The most frequently missing tooth class were molars, and first molars of older adults (34.8%) in particular, whereas canines were the least frequently missing, with none of the canines of young adults lost antemortem (0.0%). AMTL was generally much more common in posterior teeth. The opposite was the case for PMTL, in all three age groups (Figs. 5.7a and 5.7b). First incisors were the most frequently missing tooth type (32.3%, 42.3% and 25.0% for young, middle and older individuals, respectively) and first molars the least (2.9%, 5.1% and 4.3% for young, middle and older adults, respectively). In the young and middle age group, the frequency of teeth present was higher in the maxilla, whereas in the older adults, more mandibular teeth survived (Figs. 5.7a and 5.7b). Lower teeth suffered AMTL more frequently than the upper, in the first two age groups but

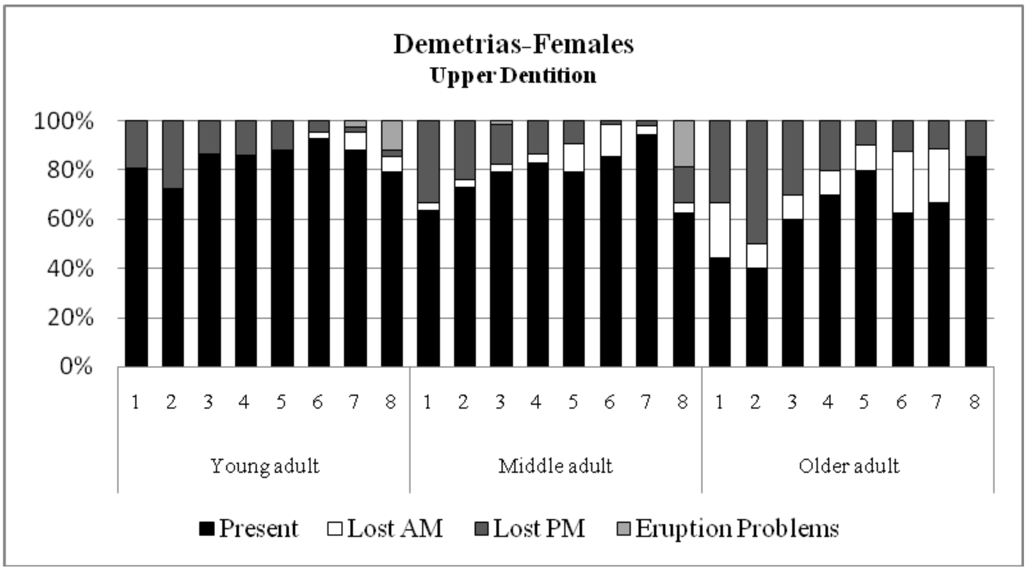

Figure 5.7a: Frequency rates of teeth present, missing antemortem, lost postmortem, and with eruption related problems for each tooth type (upper dentition), by age group, in females from Demetrias.

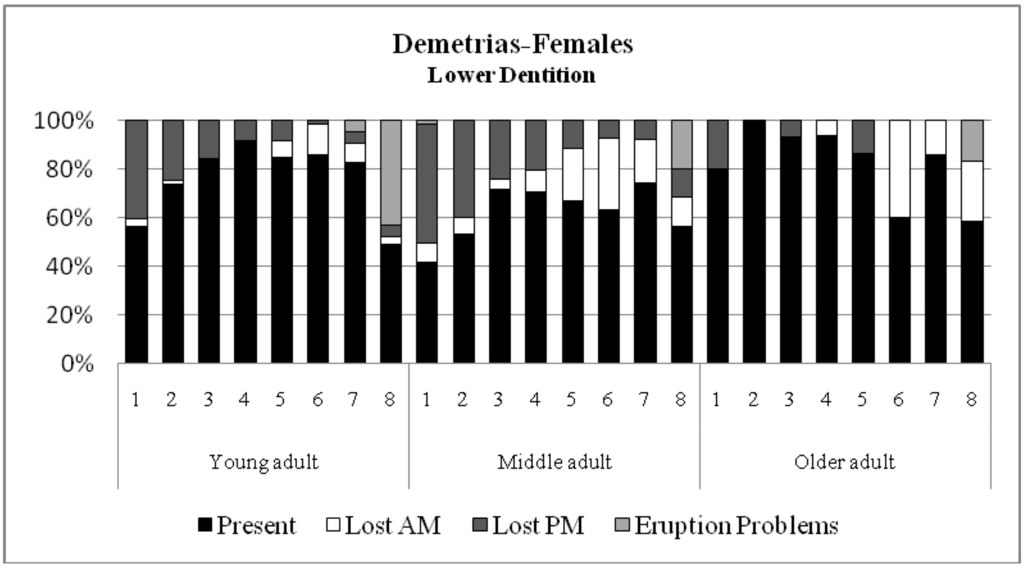

Figure 5.7b: Frequency rates of teeth present, missing antemortem, lost postmortem, and with eruption related problems in each tooth type (lower dentition), and age group, in males from Demetrias.

less often in older individuals. The same pattern was observed for PMTL. Eruption problems were much more common in mandibular teeth in all age classes (Figs. 5.7a and 5.7b).

Caries

In the female population from Demetrias, 8.8% (138 / 1571) of the permanent teeth and 41.7% (43 / 103) of individuals with surviving teeth were affected by caries. When only cavitated lesions were considered, these figures decreased to 7.4% (116 / 1571) and 40.8% (42 / 103), respectively. Of 103 female individuals with dentitions, only 8 (7.8%) had only one decayed tooth. Gross cavities, in at least one tooth, were observed in 22.3% (23 / 103) of females.

In Figures 5.8a, 5.8b and 5.8c, AMTL and caries rates, on any tooth surface and regardless of lesion type, are presented for each tooth by age group. In the younger age group, 7.8% of all teeth were carious. This slightly decreased to 7.3% in middle adults and markedly increased to 21.1% in the older individuals. The rates of AMTL were 3.5% in the young, 10.7% in the middle and 11.6% in the older individuals. Posterior teeth were affected by both caries and AMTL more often than anterior teeth. Carious lesions occured more frequently in the upper (9.3%) than in the lower dentition (8.4%). The most frequently involved teeth (upper and lower together) were third molars (12.6%) for caries and first molars for AMTL (18.5%).

In Figures 5.9a and 5.9b, caries frequency rates are presented for each tooth type by age group in female individuals, according to the severest lesion type on any surface of the tooth. Dentine lesions were the most common form in young

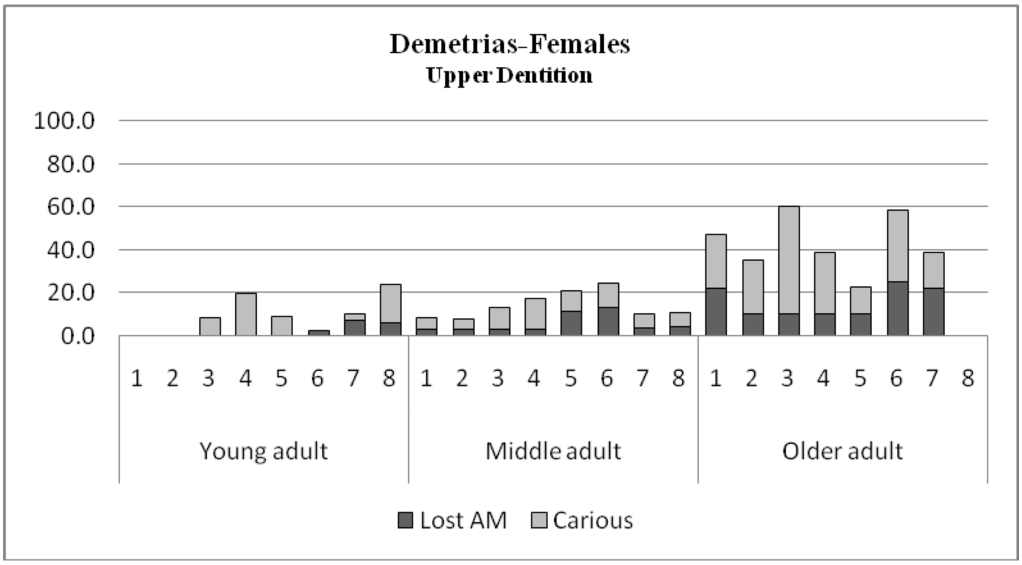

Figure 5.8a: Caries and antemortem tooth loss frequency rates for each tooth type (upper dentition), by age group, in females from Demetrias.

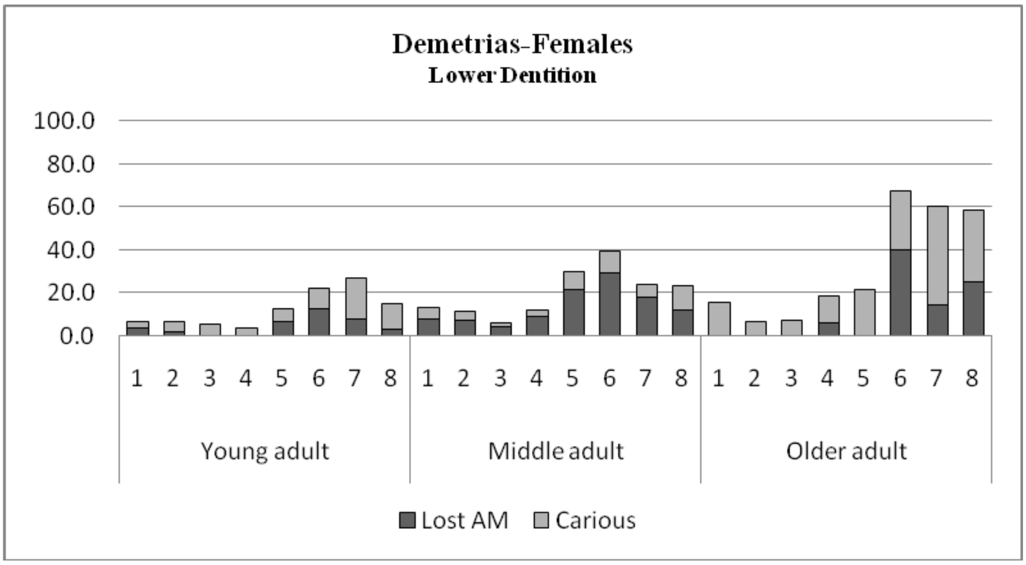

Figure 5.8b: Caries and antemortem tooth loss frequency rates for each tooth type (lower dentition), by age group, in females from Demetrias.

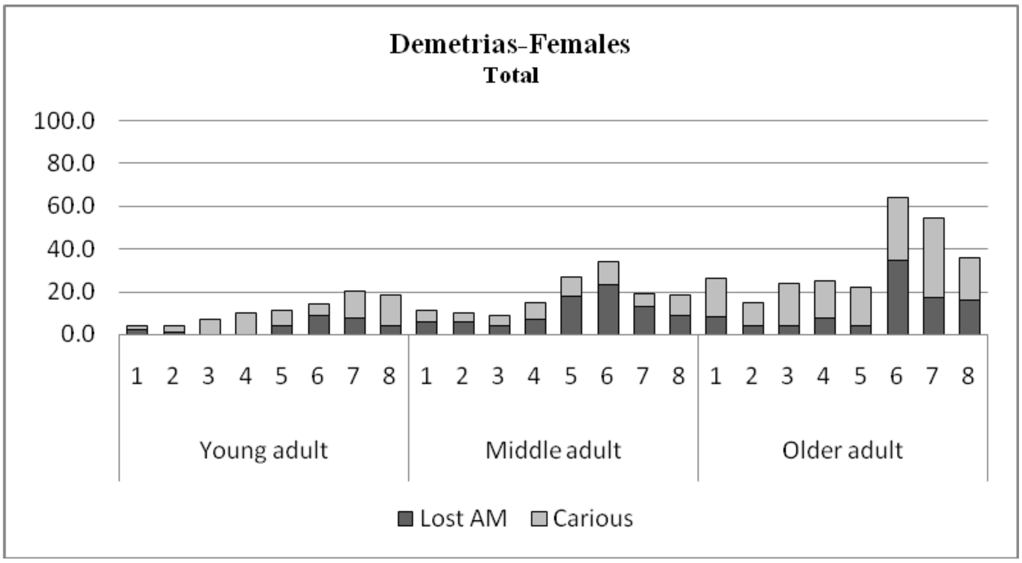

Figure 5.8c: Caries and antemortem tooth loss frequency rates for each tooth type (upper and lower dentition together), by age group, in females from Demetrias.

adults, followed by lesions penetrating to the pulp chamber and enamel lesions. In the middle age group, dentine lesion frequencies were higher than those of pulp exposing lesions, whereas enamel caries rates were very low. In the oldest age group, lesions penetrating to the dentine were by far the most common form and enamel lesions the least.

Enamel lesions were rare in all age groups with the older being the most frequently affected by this type and the middle adults, the least. Pulp exposing lesion rates steadily increased with age. Dentine lesions were approximately three and a half times more common in the older adults than in the other two age classes but younger adults showed a slightly higher frequency of this form than middle adults (Figs 5.9a and 5.9b).

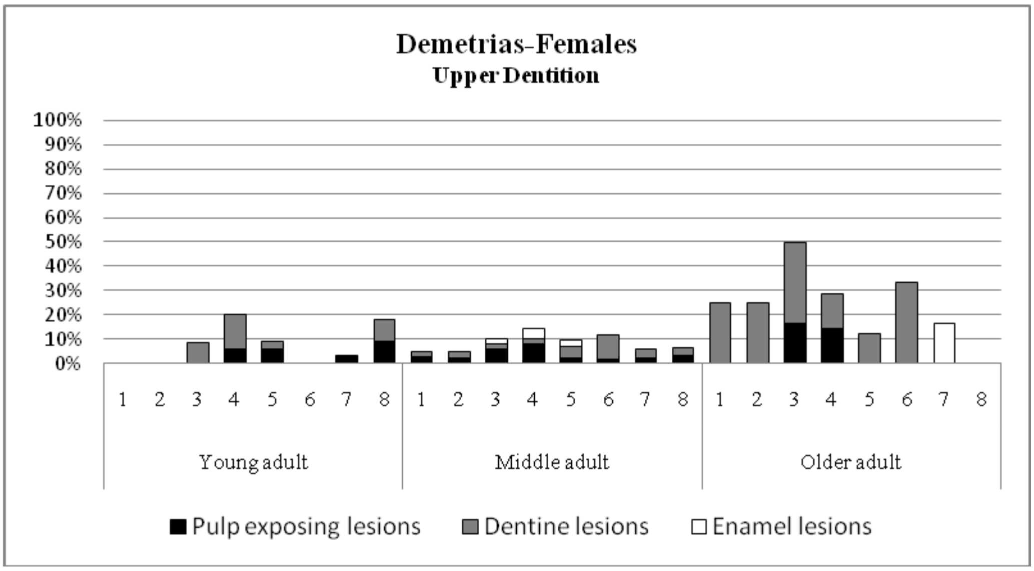

Figure 5.9a: Caries frequency rates for each tooth type (upper dentition), by age group, according to the severest lesion type on any surface of the tooth, in females from Demetrias.

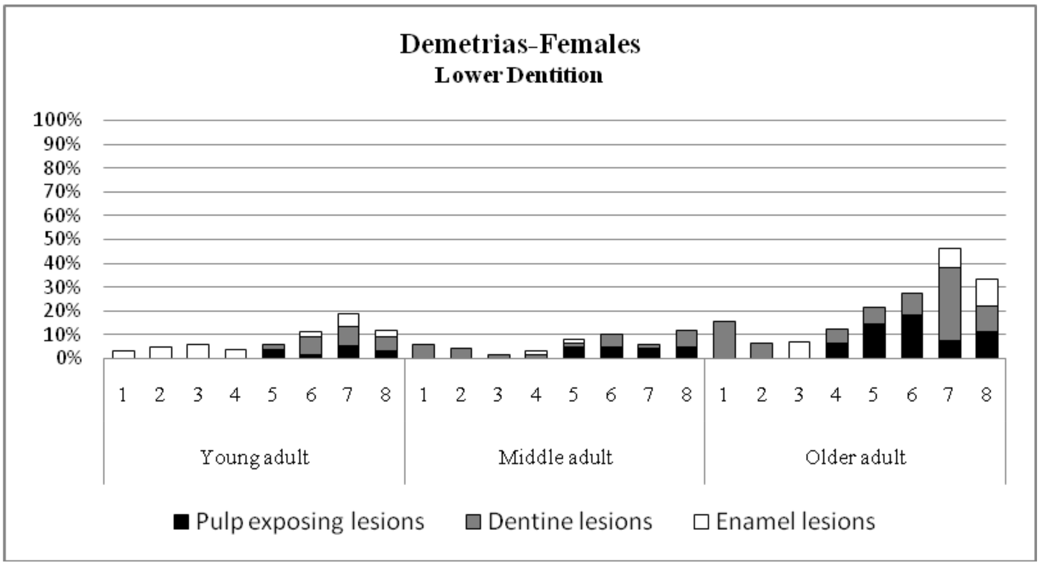

Figure 5.9b: Caries frequency rates for each tooth type (lower dentition), by age group, according to the severest lesion type on any surface of the tooth, in females from Demetrias.

Overall, pulp and dentine lesions predominated in the posterior teeth, particularly molars. Enamel lesions predominated in anterior teeth in the youngest age group only. When upper and lower dentitions were compared, pulp and dentine lesions were higher in the former, whereas lesions confined to the enamel were more common in mandibular teeth (Figs 5.9a and 5.9b).

When lesion types were considered individually, pulp exposing lesions were observed more often in posterior than anterior teeth. Dentine lesions were more common in molars than any other tooth classes but almost equally affected premolars and anterior teeth. Enamel caries rates were similar in anterior and posterior tooth types. Similar were the patterns observed separately in each age group. Lesions penetrating to the pulp chamber were predominant in both premolars and molars of all age groups. The difference between posterior and anterior teeth was more marked as age progressed. Dentine lesions were more common in the posterior teeth of young individuals but as age progressed, the difference between anterior and posterior teeth was smaller; in the oldest age class, dentine caries frequency rates were equal for first molars and first incisors. Pulp lesions more frequently affected the upper dentition of young and middle individuals and the lower dentition of older adults. Dentine lesions were more common in the upper teeth of all age groups and enamel caries in maxillary teeth of middle adults only (Figs 5.9a and 5.9b).

<u>Occlusal caries</u>

Of all occlusal surfaces examined, 4.1% (41 / 1009) showed evidence of occlusal caries. Molars (3.7%, 4.5%, 4.2% for first, second and third molars, respectively) and premolars (2.7% and 5.3% for first and second premolars, respectively) were almost equally affected. The teeth most affected were second prmolars (5.3%)

and the teeth least affected were first premolars (2.7%). The rates of occlusal surface caries were higher in the lower (4.1%) than the upper (3.9%) teeth and increased steadily through the age groups from 1.8% in young adults, to 4.3% in middle and 12.6% in older individuals.

Pit caries

Of all pit surfaces examined, 3.8% (27 / 712) showed evidence of pit caries. The percentages were higher for molars (2.4%, 5.0% and 4.9% for first, second and third molars, respectively) than incisors (2.9% and 2.9% for first and second incisors). Second molars were the most affected tooth type (5.0%) and first molars the least affected (2.4%). The rates were higher in the lower (5.2%) than the upper (2.4%) teeth and increased steadily through the age groups from 2.2% in young to 4.5% in middle and 7.0% in older individuals.

Occlusal attrition facet dentine caries

Of all occlusal attrition facets examined, 4.4% (68 / 1549) showed evidence of occlusal attrition facet dentine caries. First molars were the most frequently affected tooth type (7.0%) and canines the least (1.8%). Posterior teeth were more frequently attacked by caries in the attrition facet, with percentages ranging from 7.0% to 2.9%, whereas the rates for first and second incisors, and canines were 4.7% 3.5% and 1.8%, respectively.The frequencies of caries were higher in the upper (5.1%) than the lower (3.9%) dentition and markedly increased with age, from 2.1% in young adults to 4.7% in the middle and 12.9% in the older individuals.

Contact caries

Of all contact areas between neighbouring teeth (mesial and distal) examined, 2.9% (89 / 3042) showed evidence of contact caries. Second premolars were the most frequently affected tooth type (5.5%) and canines the least (2.0%). In general, posterior teeth were most frequently attacked by contact caries than anterior teeth. The percentages were higher in the upper (3.2%) than the lower (2.8%) dentition and markedly increased with age, from 1.8% in young adults to 2.8% in the middle and 9.3% in the older individuals.

Smooth surface caries

Of all smooth surfaces (buccal and lingual) examined, 2.5% (78 / 3081) showed evidence of smooth surface caries. First incisors were the most frequently affected tooth type (4.5%) and first molars the least (1.2%). Anterior teeth were more frequently affected than posterior. The percentages were equal for the lower (2.5%) and upper (2.5%) dentition and increased with age, from 0.8% in young adults to 2.7% in the middle and 8.8% in the older individuals.

Root surface caries

Of all root surfaces (mesial, distal, buccal and lingual) examined, 3.7% (224 / 6094) showed evidence of root surface caries. First molars were the most frequently affected tooth type (6.1%) and second incisors the least (2.5%). Posterior teeth were more frequently affected than anterior. The percentages were higher in the lower (4.2%) than the upper (3.0%) dentition and decreased from 3.3% in young to 3.2% in the middle adults and rose to 8.4% in the oldest group.

5.1.2.1.2 Males

Teeth examined and missing

The total number of observable tooth sockets for males in Demetrias was 2,836, of which, 199 (7.0%) teeth were lost antemortem and 378 (13.3%) were lost postmortem. Eruption problem were observed in 46 (1.6%) teeth. Overall, 2,213 (78.0% of observable tooth sockets) teeth were examined for the presence of carious lesions. The percentages of teeth present, lost antemortem or postmortem, and of those with eruption problems, regardless of age, are presented in Table 5.3b, and by age group, in Figures 5.10a and 5.10b for upper and lower dentition, respectively. In the youngest age group, a total of 80.9% of all teeth was present. This number decreased in middle adults (77.4%) and older individuals (75.7%). AMTL steadily increased from 2.6% in young adults to 7.1% in the middle and 13.5% in the older age group. The most frequently missing tooth class were molars, and first molars of older adults (35.7%) in particular, whereas canines were the least frequently missing, with none of the canines of young adults lost antemortem (0.0%). AMTL was generally much more common in posterior teeth. The opposite was the case for PMTL, in all three age groups (Figs. 5.10a and 5.10b). First incisors were the most frequently missing tooth type (34.2%, 38.3% and 20.4% for young, middle and older individuals, respectively) and first molars the least (0.0%, 3.2% and 1.8% for young, middle and older adults, respectively). The frequency of teeth present was higher in the maxilla in all age groups (Figs. 5.10a and 5.10b). Lower teeth suffered AMTL more frequently than the upper, in the youngest age group but less often in middle and older individuals. The exact opposite pattern was observed for PMTL; in young individuals, upper teeth were more frequently missing, whereas in the two older age groups, it was mandibular teeth that were more often lost after death. Eruption problems were much more common in mandibular teeth in all age classes (Figs. 5.10a and 5.10b).

Tooth Type		Present	Lost AM	Lost PM	Eruption Problems	Total
1	**N**	206	10	113	0	**329**
	%	62.6%	3.0%	34.3%	.0%	**100.0%**
2	**N**	226	10	101	0	**337**
	%	67.1%	3.0%	30.0%	.0%	**100.0%**
3	**N**	321	5	52	0	**378**
	%	84.9%	1.3%	13.8%	.0%	**100.0%**
4	**N**	322	13	33	0	**368**
	%	87.5%	3.5%	9.0%	.0%	**100.0%**
5	**N**	304	36	30	0	**370**
	%	82.2%	9.7%	8.1%	.0%	**100.0%**
6	**N**	301	66	8	0	**375**
	%	80.3%	17.6%	2.1%	.0%	**100.0%**
7	**N**	316	33	11	0	**360**
	%	87.8%	9.2%	3.1%	.0%	**100.0%**
8	**N**	217	26	30	46	**319**
	%	68.0%	8.2%	9.4%	14.4%	**100.0%**
Total	**N**	**2213**	**199**	**378**	**46**	**2836**
	%	**78.0%**	**7.0%**	**13.3%**	**1.6%**	**100.0%**

Table 5.3b: Number and percentages of teeth present, missing antemortem, lost postmortem, and with eruption related problems in each tooth type (upper and lower together), regardless of age, in males from Demetrias.

<u>Caries</u>

In the male population from Demetrias, 8.5% (190 / 2225) of the permanent teeth and 48.1% (65 / 135) of individuals with surviving teeth were affected by caries. When only cavitated lesions were considered, these figures decreased to 7.6% (169 / 2225) and 45.9% (62 / 135), respectively. Of 135 male individuals with dentitions, 8 (5.9%) had only one decayed tooth. Gross cavities, in at least one tooth, were observed in 27.4% (37 / 135) of males. In Figures 5.11a, 5.11b and 5.11c, AMTL and caries rates, on any tooth surface and regardless of lesion type, are presented for each tooth by age group. In the younger age group, 5.5% of all teeth were carious. This rose to 6.8% in middle adults and markedly increased to 20.1% in the older individuals.

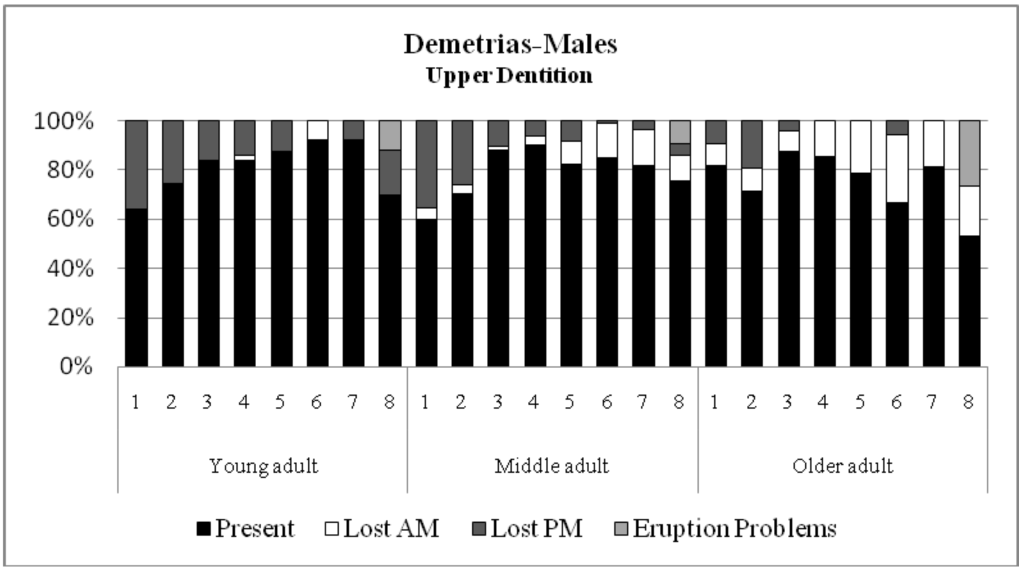

Figure 5.10a: Frequency rates of teeth present, missing antemortem, lost postmortem, and with eruption related problems for each tooth type (upper dentition), by age group, in males from Demetrias.

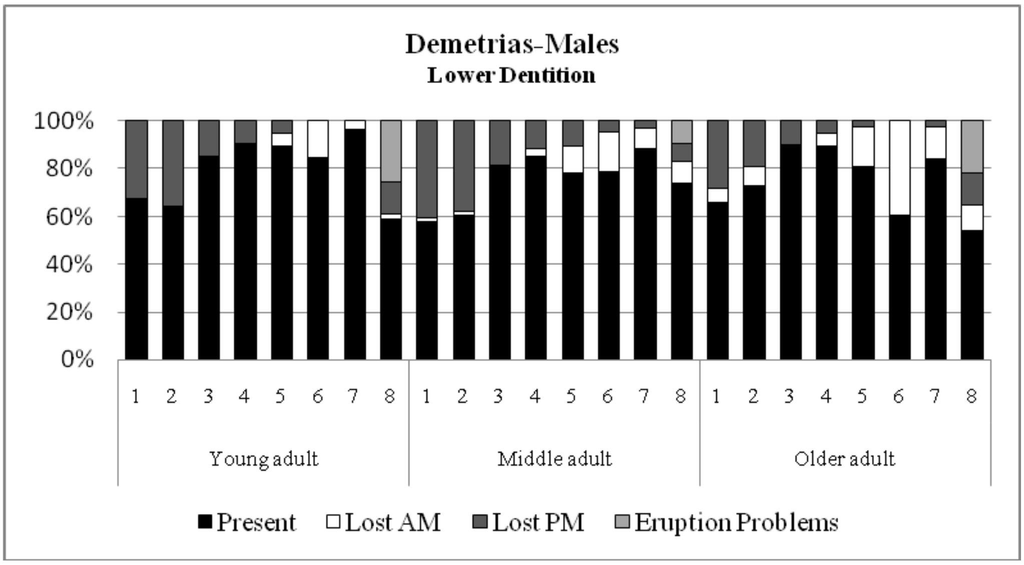

Figure 5.10b: Frequency rates of teeth present, missing antemortem, lost postmortem, and with eruption related problems for each tooth type (lower dentition), by age group, in males from Demetrias.

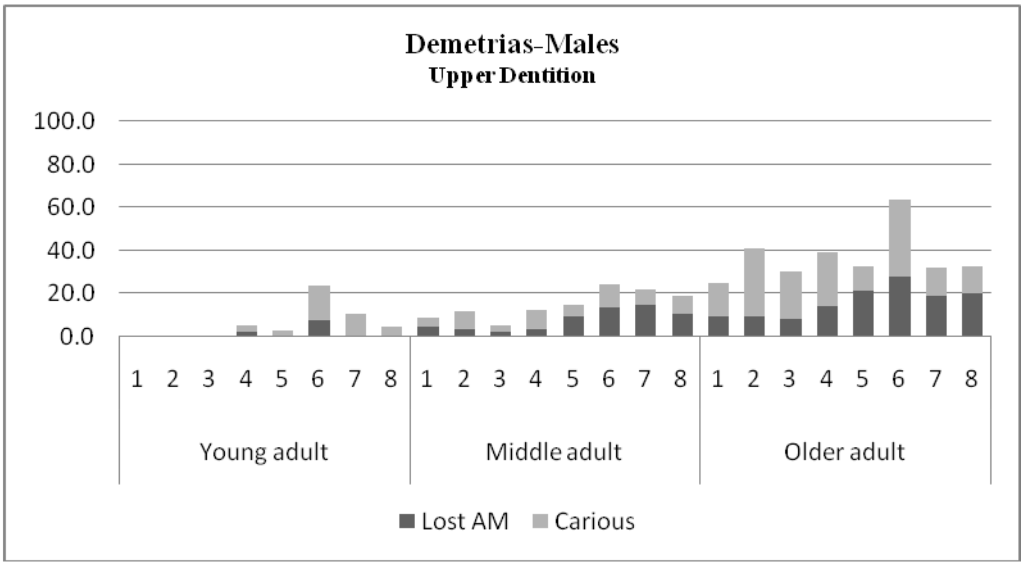

Figure 5.11a: Caries and antemortem tooth loss frequency rates for each tooth type (upper dentition), by age group, in males from Demetrias.

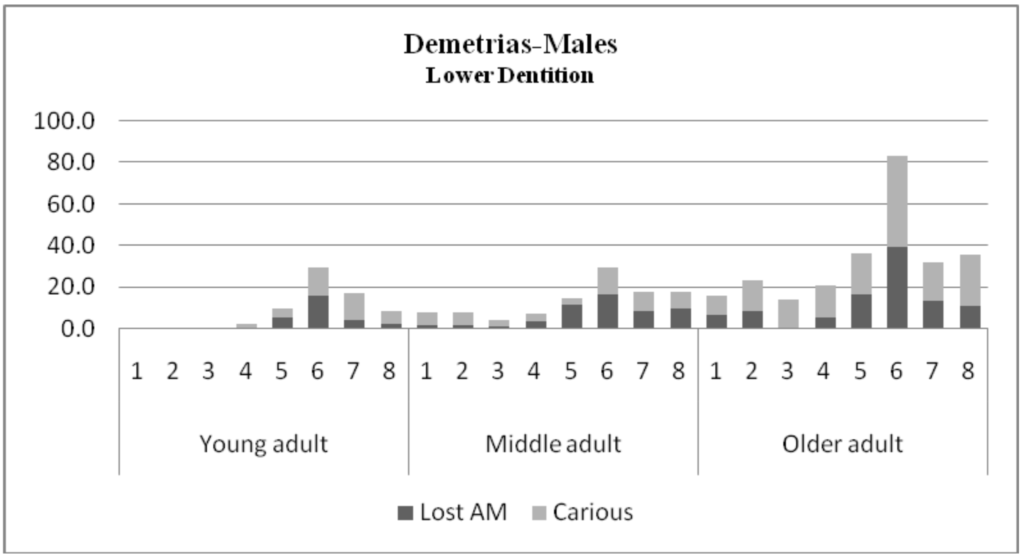

Figure 5.11b: Caries and antemortem tooth loss frequency rates for each tooth type (lower dentition), by age group, in males from Demetrias.

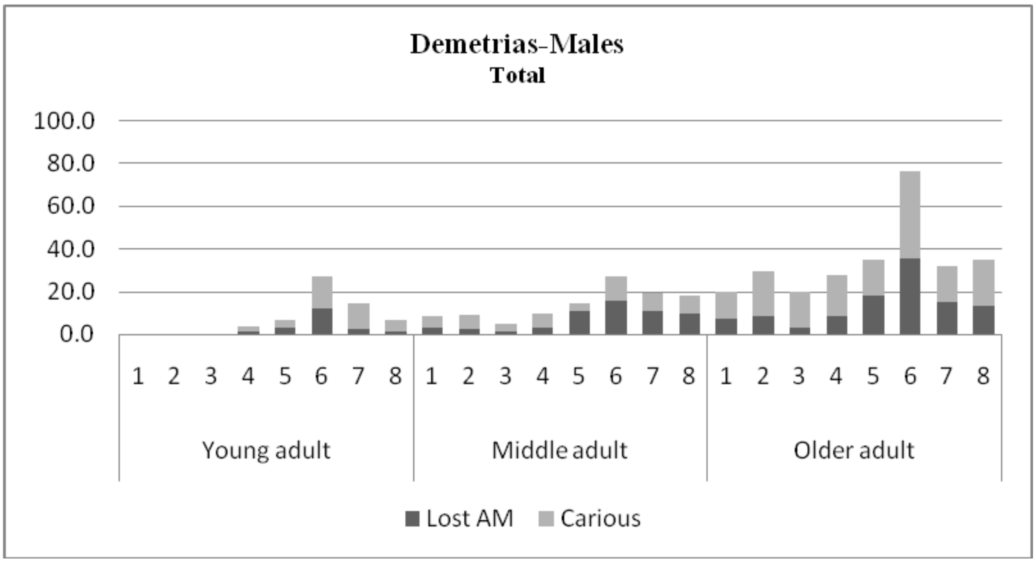

Figure 5.11c: Caries and antemortem tooth loss frequency rates for each tooth type (upper and lower dentition together), by age group, in males from Demetrias.

The rates of AMTL were 2.6% in the young, 7.1% in the middle and 13.5% in the older individuals. Posterior teeth, particularly first molars, were affected by both caries and AMTL more often than anterior teeth. Carious lesions affected upper and lower dentiitons equally (8.5%). The most frequently involved teeth (upper and lower together) were first molars for both caries (16.2%) and AMTL (17.6%).

In Figures 5.12a and 5.12b, caries frequency rates are presented for each tooth type by age group in male individuals, according to the severest lesion type on any surface of the tooth. Dentine lesions were the most common form in young adults, followed by lesions penetrating to the pulp chamber and enamel lesions. In the middle age group, pulp exposing lesion frequencies were higher than those of dentine lesions, whereas enamel caries rates were very low. In the oldest age group, dentine lesions were the most common form and enamel lesions the least.

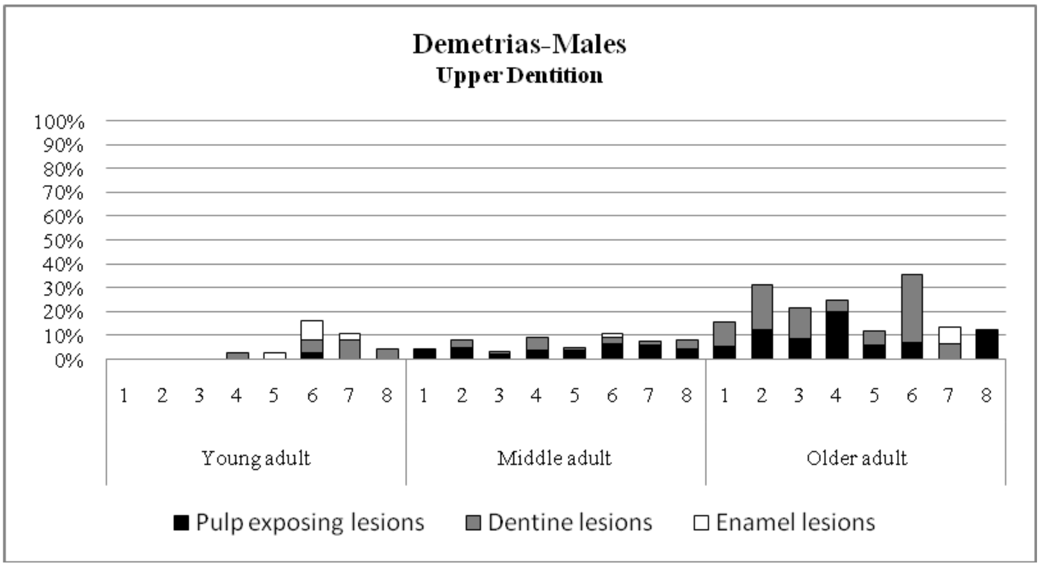

Figure 5.12a: Caries frequency rates for each tooth type (upper dentition), by age group, according to the severest lesion type on any surface of the tooth, in males from Demetrias.

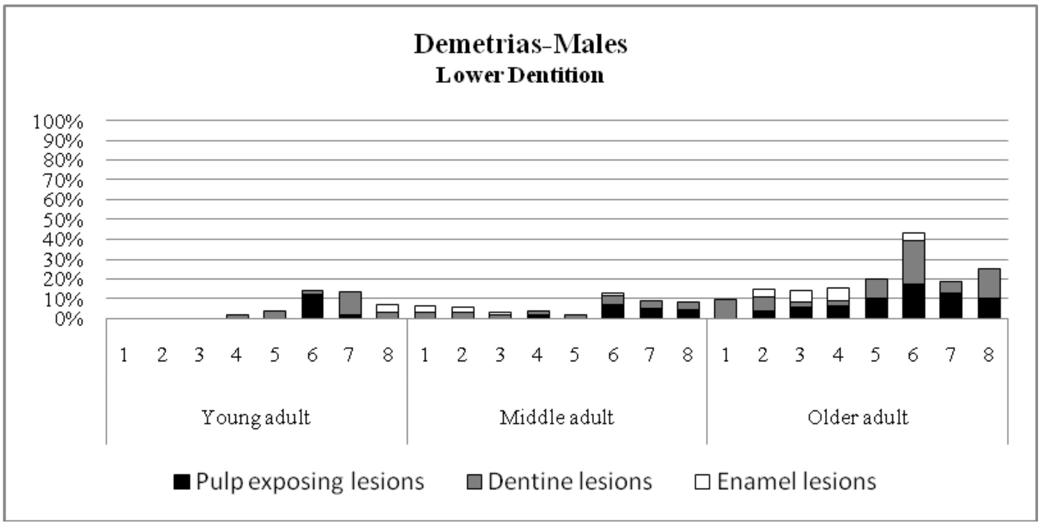

Figure 5.12b: Caries frequency rates for each tooth type (lower dentition), by age group, according to the severest lesion type on any surface of the tooth, in males from Demetrias.

Enamel lesions were rare in all age groups with the older being the most frequently affected by this type and the middle adults, the least. Pulp exposing lesion rates steadily increased with age. Dentine lesions were more than three times more common in the older adults than in the other two age classes but younger adults showed a slightly higher frequency of this form than middle adults (Figs. 5.12a & 5.12b).

Overall, pulp and dentine lesions predominated in the posterior teeth, particularly molars. Enamel lesions predominated in anterior teeth in the youngest age group only. When upper and lower dentitions were compared, pulp and dentine lesions were higher in the former, whereas lesions confined to the enamel were more common in mandibular teeth(Figs. 5.12a & 5.12b). When lesion types were considered individually, pulp exposing lesions were observed more often in posterior than anterior teeth. Dentine lesions were more common in molars than any other tooth classes but almost equally affected premolars and anterior teeth. Enamel caries rates were similar in anterior and posterior tooth types. Similar were the patterns observed separately in each age group. Lesions penetrating to the pulp chamber were predominant in both premolars and molars of all age groups. The difference between posterior and anterior teeth was more marked as age progressed. Dentine lesions were more common in the posterior teeth of young individuals but as age progressed, the difference between anterior and posterior teeth was smaller; in the oldest age class, dentine caries frequency rates were equal for first molars and first incisors. Pulp lesions more frequently affected the upper dentition of young and middle individuals and the lower dentition of older adults. Dentine lesions were more common in the upper teeth of all age groups and enamel caries in maxillary teeth of middle adults only (Figs. 5.12a & 5.12b).

In Figures 5.12a and 5.12b, caries frequency rates are presented for each tooth type by age group in male individuals, according to the severest lesion type on any surface of the tooth. Dentine lesions were the most common form in young adults, followed by lesions penetrating to the pulp chamber and enamel lesions. In the middle age group, dentine lesion frequencies were higher than those of pulp exposing lesions, whereas enamel caries rates were very low. In the oldest age group, lesions penetrating to the dentine were by far the most common form and enamel lesions the least (Figs. 5.12a & 5.12b).

Enamel lesions were rare in all age groups with the older being the most frequently affected by this type and the middle adults, the least. Pulp exposing lesion rates steadily increased with age. Dentine lesions were three times more common in the older adults than in the other two age classes but younger adults showed a slightly higher frequency of this form than middle adults (Figs. 5.12a & 5.12b).

Overall, pulp and dentine lesions predominated in the posterior teeth, particularly molars. Enamel lesions predominated in anterior teeth in the middle age group only. When upper and lower dentitions were compared, pulp lesions only were higher in the former, whereas dentine and enamel lesions were more common in mandibular teeth (Figs. 5.12a & 5.12b).

When lesion types were considered individually, pulp exposing lesions were observed more often in posterior than anterior teeth. Dentine lesions were more common in molars than any other tooth classes but anterior teeth were equally or more affected than premolars. Enamel caries rates were similar in anterior and posterior tooth types. Similar were the patterns observed separately in each age group. Lesions penetrating to the pulp chamber, as well as dentine lesions, were predominant in both premolars and molars of all age groups. The difference between posterior and anterior teeth was more marked for pulp lesions, as age progressed. Enamel caries affected posterior teeth more frequently in the youngest age group, whereas the opposite was the case in the middle age group. In older adults, rates of enamel lesions were similar in anterior and posterior. Pulp lesions more frequently affected the upper dentition of middle and older individuals and the lower dentition of young adults. Dentine lesions were more common in the lower teeth of the first two age groups and enamel caries in maxillary teeth of young adults only (Figs. 5.12a & 5.12b).

Occlusal caries

Of all occlusal surfaces examined, 4.2% (60 / 1424) showed evidence of occlusal caries. Molars were more frequently affected (6.1%, 5.1%, 5.2% for first, second and third molars, respectively) than premolars (3.2% and 1.7% for first and second premolars, respectively). The teeth most affected were first molars (6.1%) and the teeth least affected were second molars (1.1%). The rates of occlusal surface caries were higher in the lower (4.5%) than the upper (3.8%) teeth, and decreased from 4.1% in young to 3.9% in middle adults, and then rose to 5.9% in older individuals.

Pit caries

Of all pit surfaces examined, 4.3% (42 / 981) showed evidence of pit caries. The percentages were higher for molars (5.5%, 3.6% and 4.2% for first, second and third molars, respectively) than incisors (2.5% and 4.4% for first and second incisors). First molars were the most affected tooth type (5.5%) and first incisors the least affected (2.5%). The rates were higher in the lower (5.2%) than the upper (3.3%) teeth and increased through the first two age groups from 4.4% in young to 4.5% in middle adults and decreased to 3.1% in older individuals.

Occlusal attrition facet dentine caries

Of all occlusal attrition facets examined, 4.2% (94 / 2225) showed evidence of occlusal attrition facet dentine caries. First molars were the most frequently affected tooth type (7.9%) and canines the least (2.2%). Posterior teeth were more frequently attacked by caries in the attrition facet, with percentages ranging from 7.9% to 3.3%, whereas the rates for first and second incisors, and canines were 3.9% 4.8% and 2.2%, respectively. The frequencies of caries were higher in the lower (4.4%) than the upper (4.1%) dentition and markedly increased with age, from 1.7% in young adults to 3.9% in the middle and 9.6% in the older individuals.

Contact caries

Of all contact areas between neighbouring teeth (mesial and distal) examined, 3.6% (156 / 4317) showed evidence of contact caries. First molars were the most frequently affected tooth type (6.5%) and canines the least (1.8%). In general, posterior teeth were most frequently attacked by contact caries than anterior teeth. The percentages were equal for the upper (3.6%) and lower (3.6%) dentition and markedly increased with age, from 1.6% in young adults to 3.7% in the middle and 7.0% in the older individuals.

Smooth surface caries

Of all smooth surfaces (buccal and lingual) examined, 2.5% (111 / 4390) showed evidence of smooth surface caries. Second incisors and first premolars were the most frequently affected tooth types (3.6%) and first incisors the least (1.3%). Posterior teeth were more frequently affected than anterior. The percentages were higher for the lower (3.0%) than the upper (1.9%) dentition and increased with age, from 0.5% in young adults to 2.5% in the middle and 5.9% in the older individuals.

Root surface caries

Of all root surfaces (mesial, distal, buccal and lingual) examined, 3.4% (294 / 8761) showed evidence of root surface caries. First molars were the most frequently affected tooth type (5.8%) and canines the least (1.9%). Posterior teeth were more frequently affected than anterior. The percentages were higher in the lower (3.9%) than the upper (2.6%) dentition and increased with age from 0.9% in young adults to 3.2% in the middle and 8.3% in the oldest group.

5.1.2.2 Athens

5.1.2.2.1 Females

Teeth examined and missing

The total number of observable tooth sockets for females in Athens was 2,858, of which, 1,429 (50.0%) teeth were lost antemortem and 802 (28.1%) were lost postmortem. Eruption problems were observed in 60 (2.1%) teeth and 6 (0.2%) were unobservable. Overall, 561 (19.6% of observable tooth sockets) teeth were examined for the presence of carious lesions. The percentages of teeth present,

Tooth Type		Present	Lost AM	Lost PM	Unobservable	Eruption Problems	Total
1	**N**	36	135	184	2	0	**357**
	%	10.1%	37.8%	51.5%	.6%	.0%	**100.0%**
2	**N**	52	138	163	3	0	**356**
	%	14.6%	38.8%	45.8%	.8%	.0%	**100.0%**
3	**N**	76	135	147	1	0	**359**
	%	21.2%	37.6%	40.9%	.3%	.0%	**100.0%**
4	**N**	65	181	112	0	0	**358**
	%	18.2%	50.6%	31.3%	.0%	.0%	**100.0%**
5	**N**	62	193	104	0	0	**359**
	%	17.3%	53.8%	29.0%	.0%	.0%	**100.0%**
6	**N**	100	230	28	0	0	**358**
	%	27.9%	64.2%	7.8%	.0%	.0%	**100.0%**
7	**N**	111	208	37	0	1	**357**
	%	31.1%	58.3%	10.4%	.0%	.3%	**100.0%**
8	**N**	59	209	27	0	59	**354**
	%	16.7%	59.0%	7.6%	.0%	16.7%	**100.0%**
Total	**N**	**561**	**1429**	**802**	**6**	**60**	**2858**
	%	**19.6%**	**50.0%**	**28.1%**	**.2%**	**2.1%**	**100.0%**

Table 5.4a: Number and percentages of teeth present, missing antemortem, lost postmortem, and with eruption related problems in each tooth type (upper and lower together), regardless of age, in females from Athens.

lost antemortem or postmortem, and of those with eruption problems, regardless of age, are presented in Table 5.4a, and by age group, in Figures 5.13a and 5.13b for upper and lower dentition, respectively. In the youngest age group, a total of 56.6% of all teeth was present. This number dramatically decreased in middle (23.6%) and older individuals (9.9%). AMTL steadily increased from 5.9% in young adults to 33.9% in the middle and 71.1% in the older age group. The most frequently missing tooth class were molars, and first molars of older adults (81.7%) in particular, whereas canines were the least frequently missing, with none of the canines of young adults lost antemortem (0.0%). AMTL was generally much more common in posterior teeth. The opposite was the case for PMTL, in all three age groups (Figures 5.13a and 5.13b). First incisors were the most frequently missing (PMTL) tooth type (65.6%,

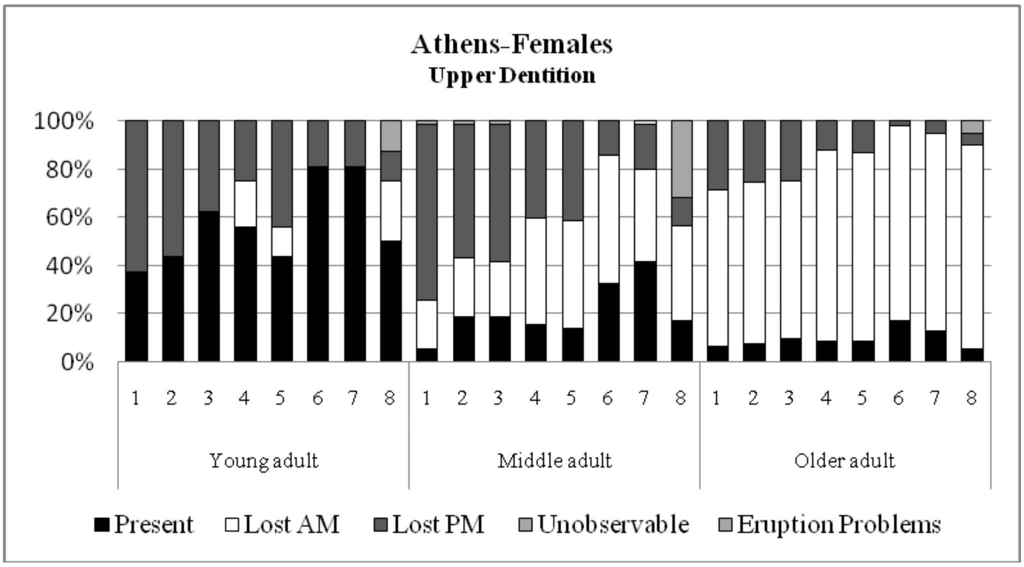

Figure 5.13a: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (upper dentition), by age group, in females from Athens.

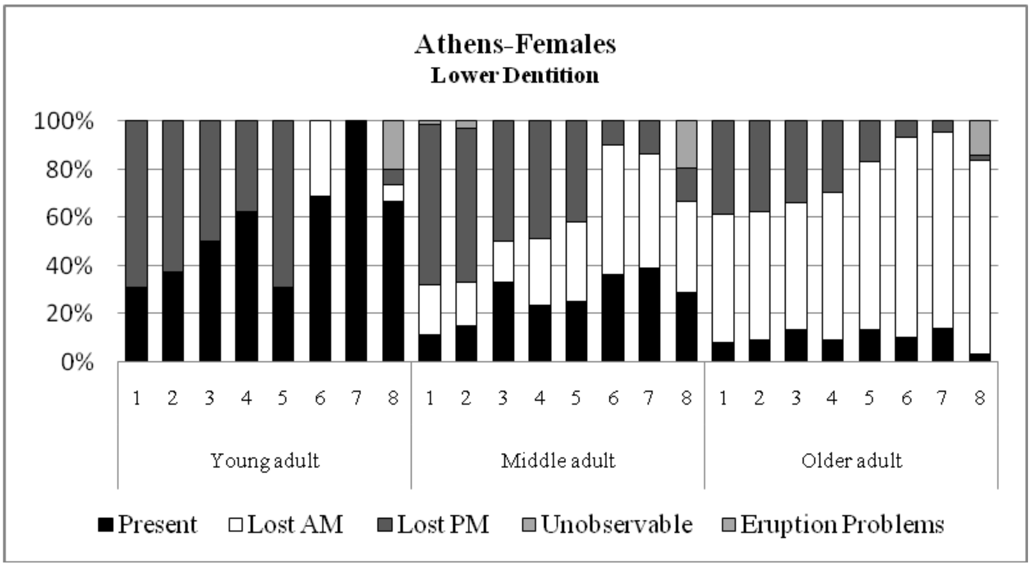

Figure 5.13b: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (lower dentition), by age group, in females from Athens.

69.7% and 33.5% for young, middle and older individuals, respectively) and third molars the least (9.7%, 12.8% and 3.4% for young, middle and older adults, respectively). In the youngest age group, the frequency of teeth present was higher in the maxilla, whereas in middle and older adults, more mandibular teeth survived (Figures 5.13a and 5.13b.). Upper teeth suffered AMTL more frequently than the lower, in all age groups. Mandibular teeth were lost postmortem more often in the young and older age groups but less often in the middle age group. Eruption problems were much more common in mandibular teeth in the young and older age classes but less common in the middle age class.

Caries

In the female population from Athens, 45.8% (256 / 559) of the permanent teeth and 84.5% (49 / 58) of individuals with surviving teeth were affected by caries. When only cavitated lesions were considered, the first figure decreased to 43.6% (244 / 559), whereas the second remained the same (84.5%, 49 / 58). Of 58 female individuals with dentitions, only 9 (6.9%) had only one decayed tooth. Gross cavities, in at least one tooth, were observed in 39.7% (23 / 58) of females. It should be noted that all the above figures, except the last one (gross cavities), include fillings.

In Figures 5.14a, 5.14b and 5.14c, AMTL and caries rates, on any tooth surface and regardless of lesion type, are presented for each tooth by age group. In the younger age group, 35.9% of all teeth were carious. This increased to 49.6% in middle adults and again decreased to 46.0% in the older individuals. The rates of AMTL were 5.9% in the young, 33.9% in the middle and 71.1% in the older individuals. Posterior teeth were affected by both caries and AMTL more often

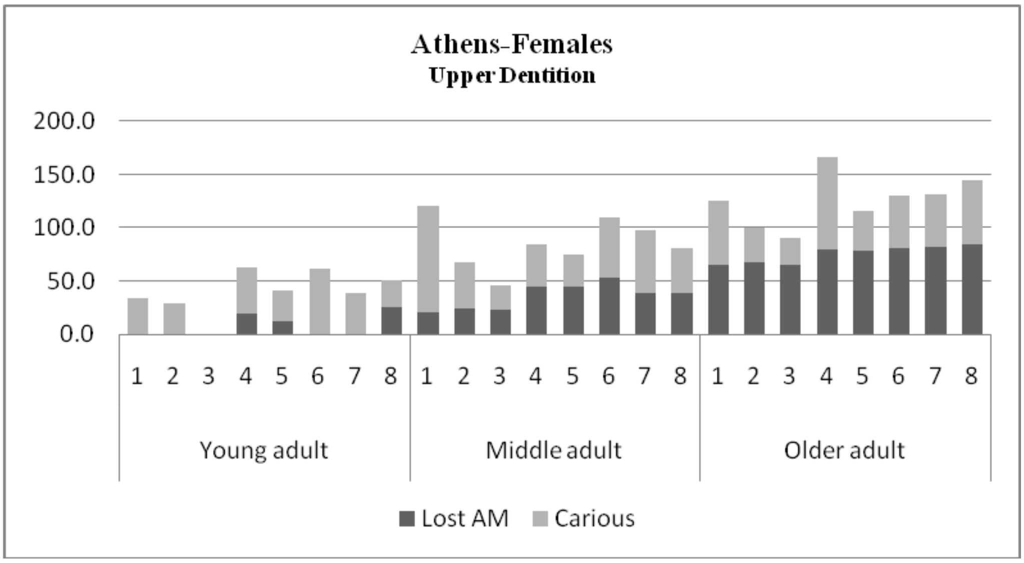

Figure 5.14a: Caries and antemortem tooth loss frequency rates for each tooth type (upper dentition), by age group, in females from Athens.

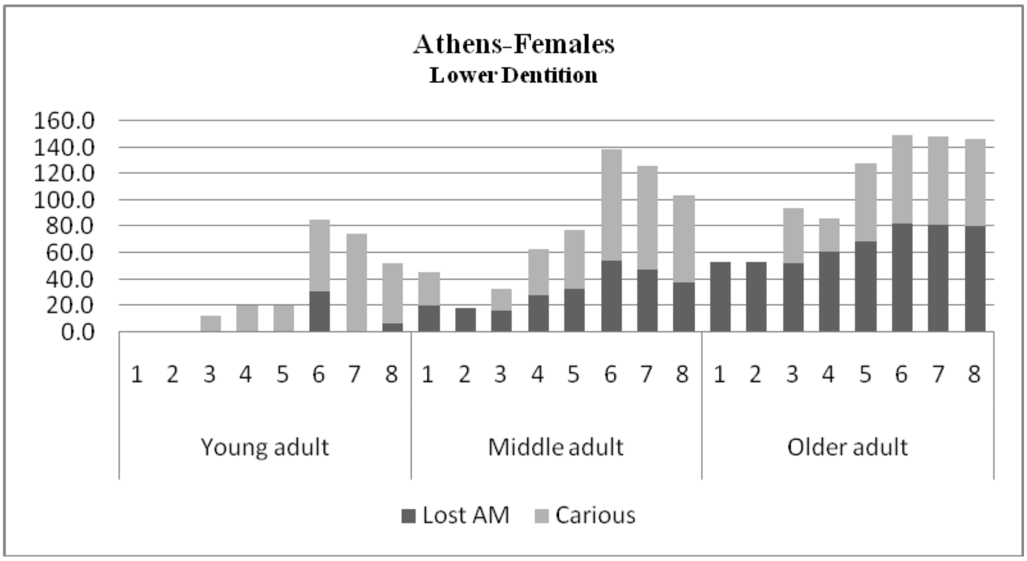

Figure 5.14b: Caries and antemortem tooth loss frequency rates for each tooth type (lower dentition), by age group, in females from Athens.

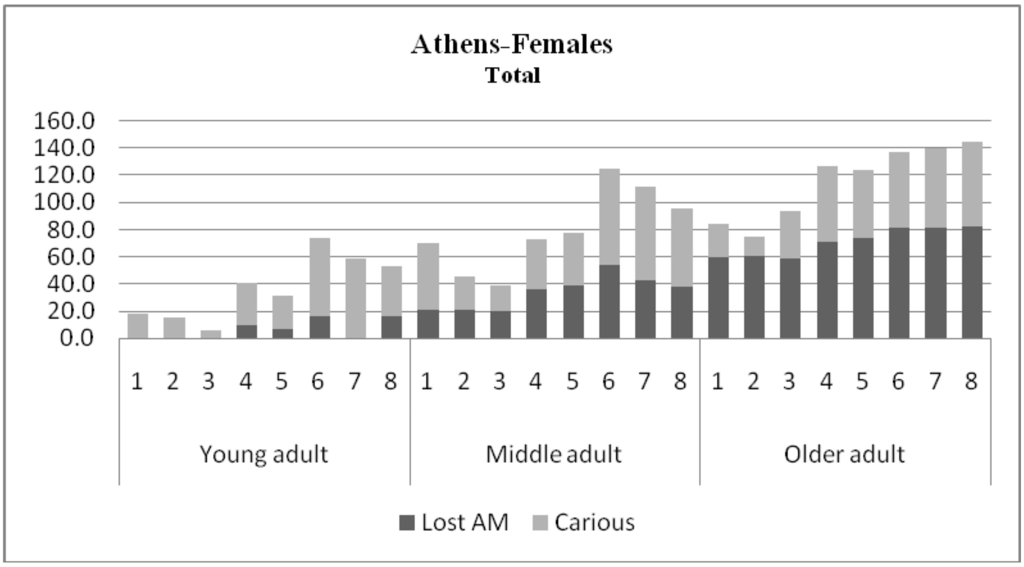

Figure 5.14c: Caries and antemortem tooth loss frequency rates for each tooth type (upper and lower dentition together), by age group, in females from Athens.

than anterior teeth, with the exception of first incisors of middle adults, which showed markedly higher rates of caries than premolars. Carious lesions equally affected upper and lower dentiitons (45.8%). The most frequently involved teeth (upper and lower together) were first molars for both caries (65.0%) and AMTL (64.2%).

In Figures 5.15a and 5.15b, caries frequency rates are presented for each tooth type by age group in female individuals, according to the severest lesion type on any surface of the tooth. Dentine lesions were the most common form in young adults, followed by enamel lesions and lesions penetrating to the pulp chamber. In the middle age group, dentine lesion frequencies were higher than those of pulp exposing lesions, whereas enamel caries rates were very low. In the oldest age group, lesions penetrating to the pulp chamber were by far the most common form and enamel lesions the least. Fillings'rates were very high and much more common than any other type of lesion, in all age groups.

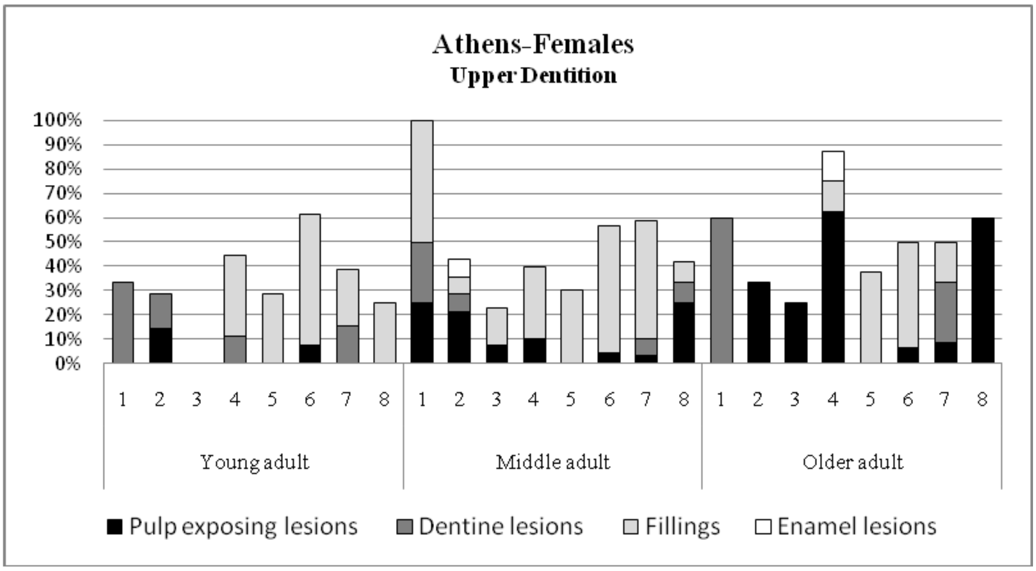

Figure 5.15a: Caries frequency rates for each tooth type (upper dentition), by age group, according to the severest lesion type on any surface of the tooth, in females from Athens.

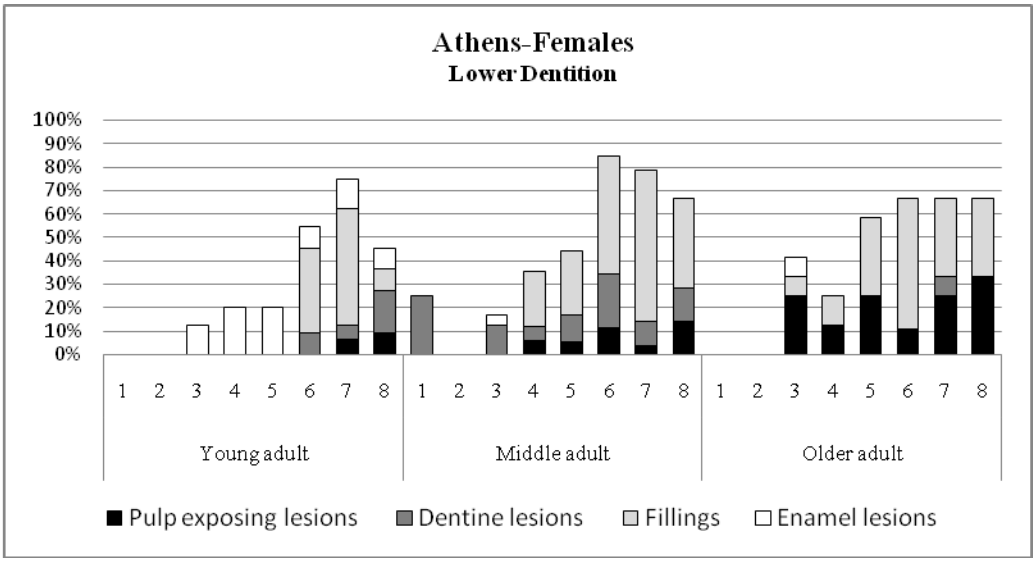

Figure 5.15b: Caries frequency rates for each tooth type (lower dentition), by age group, according to the severest lesion type on any surface of the tooth, in females from Athens.

Enamel lesions were rare in all age groups with the young being the most frequently affected by this type and the middle adults, the least. Pulp exposing lesion rates steadily increased with age. Dentine lesion rates increased from the youngest to the middle adult age group but decreased in older individuals. The highest percentages of fillings were observed in middle adults and the lowest in young individuals (5.15a & 5.15b).

Overall, pulp lesions predominated in the posterior teeth, particularly molars, whereas dentine lesions were more common in first incisors than any other tooth type. Enamel lesion rates were very similar between posterior and anterior teeth. Fillings were markedly more frequent in the posterior teeth. When upper and lower dentitions were compared, pulp lesions and fillings were higher in the former, whereas lesions penetrating to the dentine and those confined to the enamel were more common in mandibular teeth (5.15a & 5.15b).

Similar were the patterns observed separately in each age group. Lesions penetrating to the pulp chamber were predominant in molars, but also second incisors, of young adults. In the middle and older age groups, pulp lesions were more common in posterior teeth. Dentine lesions were more frequent in the anterior teeth of all age groups. Fillings' rates were higher in the posterior teeth in all age classes. Pulp lesions more frequently affected the upper dentition of middle and older individuals and the lower dentition of young adults. Enamel lesions were more common in the posterior teeth of young adults, the anterior teeth of middle adults, and almost equally affected anterior and posterior teeth in the oldest age group. Dentine lesions were more common in the upper teeth of young and older age groups and enamel caries in maxillary teeth of middle and older adults. Fillings' rates were higher in upper dentition of young and middle adults and in the lower dentition of older adults (5.15a & 5.15b).

Occlusal caries

Of all occlusal surfaces examined, 45.4% (176 / 388) showed evidence of occlusal caries. Molars (56.0%, 48.6%, 50.0% for first, second and third molars, respectively) were markedly more frequently affected than premolars (30.2% and 32.8% for first and second premolars, respectively). The teeth most affected were first molars (56.0%) and the teeth least affected were first premolars (30.2%). The rates of occlusal surface caries were higher in the lower (49.0%) than the upper (41.5%) teeth and increased from 37.6% in young adults to 51.3% in middle, but they decreased to 37.1% in older individuals.

Pit caries

Of all pit surfaces examined, 49.5% (151 / 305) showed evidence of pit caries. The percentages were higher for molars (55.1%, 53.7% and 48.3% for first, second and third molars, respectively) than incisors (33.3% and 23.1% for first and second incisors). First molars were the most affected tooth type (55.1%) and second incisors the least affected (23.1%). The rates were higher in the lower (59.7%) than the upper (41.5%) teeth and increased through the first two age groups from 41.7% in young to 58.6% in middle adults but decreased to 36.4% in older individuals.

Occlusal attrition facet dentine caries

Of all occlusal attrition facets examined, 23.9% (131 / 547) showed evidence of occlusal attrition facet dentine caries. First molars were the most frequently affected tooth type (39.4%) and first incisors the least (2.9%). Posterior teeth were more frequently attacked by caries in the attrition facet, with percentages ranging from 25.4% to 39.4%, whereas the rates for first and second incisors, and canines were 2.9% 6.1% and 8.3%, respectively. The frequencies of caries were higher in the upper (25.8%) than the lower (22.3%) dentition and markedly increased with age, from 13.1% in young adults to 26.8% in the middle and 26.2% in the older individuals.

Contact caries

Of all contact areas between neighbouring teeth (mesial and distal) examined, 21.2% (235 / 1106) showed evidence of contact caries. First molars were the most frequently affected tooth type (32.7%) and canines the least (4.3%). In general, posterior teeth were markedly most frequently attacked by contact caries than anterior teeth. The percentages were higher in the upper (22.5%) than the lower (20.1%) dentition and steadily increased with age, from 15.7% in young adults to 20.2% in the middle and 25.0% in the older individuals.

Smooth surface caries

Of all smooth surfaces (buccal and lingual) examined, 15.0% (167 / 1114) showed evidence of smooth surface caries. First molars were the most frequently affected tooth type (21.1%) and first incisors the least (4.3%). Posterior teeth were more frequently affected than anterior. The percentages were higher for the lower

(17.0%) than the upper (12.7%) dentition and increased with age, from 11.4% in young adults to 12.9% in the middle and 20.9% in the older individuals.

<u>Root surface caries</u>

Of all root surfaces (mesial, distal, buccal and lingual) examined, 6.5% (145 / 2219) showed evidence of root surface caries. Third molars were the most frequently affected tooth type (8.8%) and first incisors the least (0.0%). Posterior teeth were more frequently affected than anterior. The percentages were higher in the upper (7.4%) than the lower (5.8%) dentition and increased from 1.4% in young to 4.7% in the middle adults and rose to 14.2% in the oldest group.

5.1.2.2.2 Males

<u>Teeth examined and missing</u>

The total number of observable tooth sockets for males in Athens was 3,510, of which, 1,902 (54.2%) teeth were lost antemortem and 839 (23.9%) were lost postmortem. Eruption problems were observed in 50 (1.4%) teeth and 6 (0.2%) were unobservable. Overall, 713 (20.3% of observable tooth sockets) teeth were examined for the presence of carious lesions. The percentages of teeth present, lost antemortem or postmortem, and of those with eruption problems, regardless of age, are presented in Table 5.4b, and by age group, in Figures 5.16a and 5.16b, for upper and lower dentition, respectively. In the youngest age group, a total of 47.3% of all teeth was present. This number dramatically decreased in middle (25.7%) and older individuals (7.4%). AMTL steadily increased from 10.4% in young adults to 37.3% in the middle and 80.4% in the older age group. The most frequently missing (AMTL) tooth class were molars,

Tooth Type		Present	Lost AM	Lost PM	Unobser vable	Eruption Problems	Total
1	**N**	58	189	188	0	0	**435**
	%	13.3%	43.4%	43.2%	.0%	.0%	**100.0%**
2	**N**	70	194	172	0	0	**436**
	%	16.1%	44.5%	39.4%	.0%	.0%	**100.0%**
3	**N**	105	182	149	1	0	**437**
	%	24.0%	41.6%	34.1%	.2%	.0%	**100.0%**
4	**N**	99	241	100	1	0	**441**
	%	22.4%	54.6%	22.7%	.2%	.0%	**100.0%**
5	**N**	76	265	95	0	3	**439**
	%	17.3%	60.4%	21.6%	.0%	.7%	**100.0%**
6	**N**	99	301	40	0	0	**440**
	%	22.5%	68.4%	9.1%	.0%	.0%	**100.0%**
7	**N**	126	269	45	0	1	**441**
	%	28.6%	61.0%	10.2%	.0%	.2%	**100.0%**
8	**N**	80	261	50	4	46	**441**
	%	18.1%	59.2%	11.3%	.9%	10.4%	**100.0%**
Total	**N**	**713**	**1902**	**839**	**6**	**50**	**3510**
	%	**20.3%**	**54.2%**	**23.9%**	**.2%**	**1.4%**	**100.0%**

Table 5.4b: Number and percentages of teeth present, missing antemortem, lost postmortem, and with eruption related problems in each tooth type (upper and lower together), regardless of age, in males from Athens.

and first molars of older adults (89.5%) in particular, whereas canines were the least frequently missing, with 1.3 of the canines of young adults lost antemortem. AMTL was generally much more common in posterior teeth. The opposite was the case for PMTL, in all three age groups (Figs. 5.16a & 5.16b). First incisors were the most frequently missing (PMTL) tooth type (77.0%, 58.9% and 21.8% for young, middle and older individuals, respectively) and first molars the least (9.0%, 17.6% and 3.6% for young, middle and older adults, respectively). The frequency of teeth present and lost postmortem was higher in the mandible in all age classes (Figs. 5.16a & 5.16b). Upper teeth suffered AMTL more frequently than the lower, in all age groups. Eruption problems were much more common in mandibular teeth in older individuals but less common in young and middle adults (Figs. 5.16a & 5.16b).

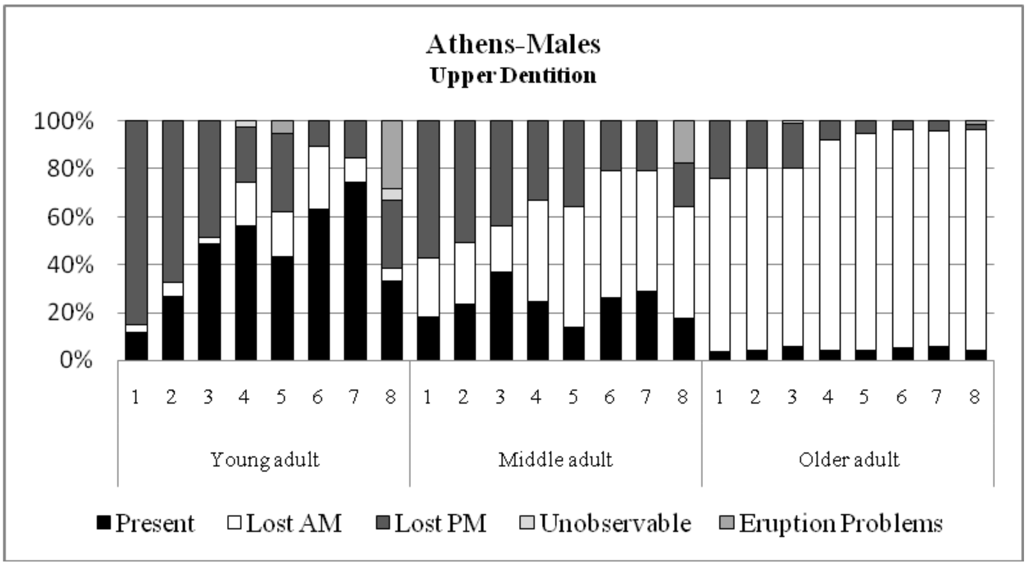

Figure 5.16a: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (upper dentition), by age group, in males from Athens.

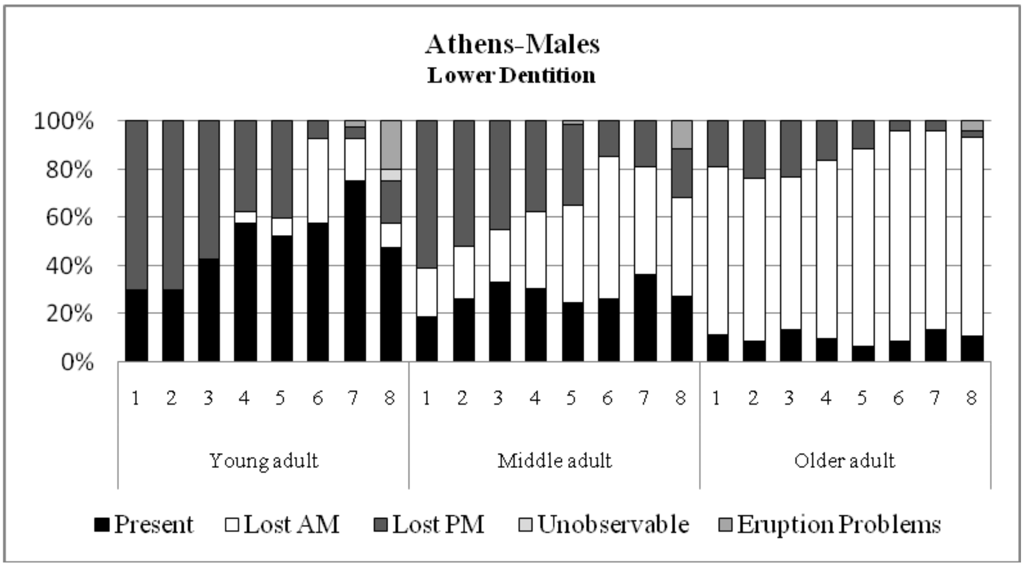

Figure 5.16b: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (lower dentition), by age group, in males from Athens.

Caries

In the male population from Athens, 45.8% (329 / 718) of the permanent teeth and 97.0% (64 / 66) of individuals with surviving teeth were affected by caries. When only cavitated lesions were considered, the first figure decreased to 42.1% (302 / 717), whereas the second remained the same (97.0%, 64 / 66). Of 66 male individuals with dentitions, only 10 (15.2%) had only one decayed tooth. Gross cavities, in at least one tooth, were observed in 45.5% (30 / 66) of males. It should be noted that all the above figures, except the last one (gross cavities), include fillings.

In Figures 5.17a, 5.17b and 5.17c, AMTL and caries rates, on any tooth surface and regardless of lesion type, are presented for each tooth by age group. In the younger age group, 45.4% of all teeth were carious. This decreased to 43.5% in middle adults and again increased to 51.9% in the older individuals. The rates of AMTL were 10.4% in the young, 37.3% in the middle and 80.4% in the older individuals. Posterior teeth were affected by both caries and AMTL more often than anterior teeth. Caries affected the lower (47.3%) more often than the upper (44.0%) dentition. The most frequently involved teeth (upper and lower together) were first molars for both caries (66.7%) and AMTL (68.4%).

In Figures 5.18a and 5.18b, caries frequency rates are presented for each tooth type by age group in male individuals, according to the severest lesion type on any surface of the tooth. Dentine lesions were the most common form in young adults, followed by lesions penetrating to the pulp chamber and enamel lesions.

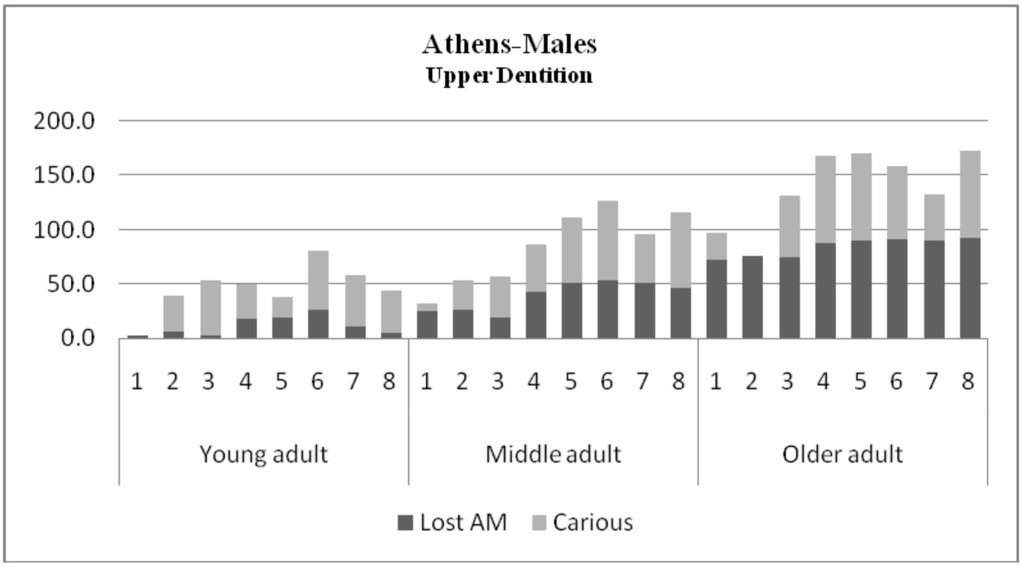

Figure 5.17a: Caries and antemortem tooth loss frequency rates for each tooth type (upper dentition), by age group, in males from Athens.

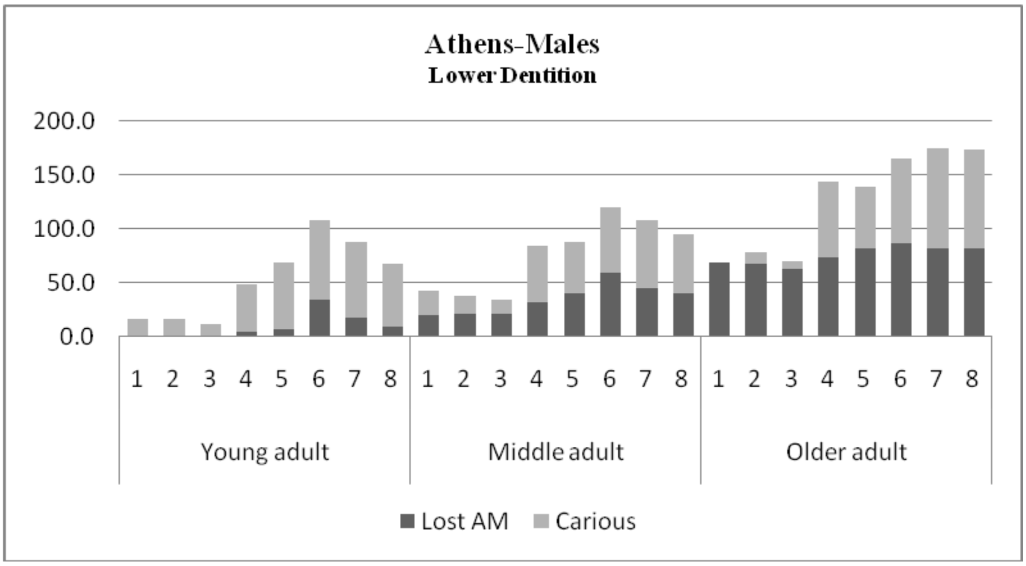

Figure 5.17b: Caries and antemortem tooth loss frequency rates for each tooth type (lower dentition), by age group, in males from Athens.

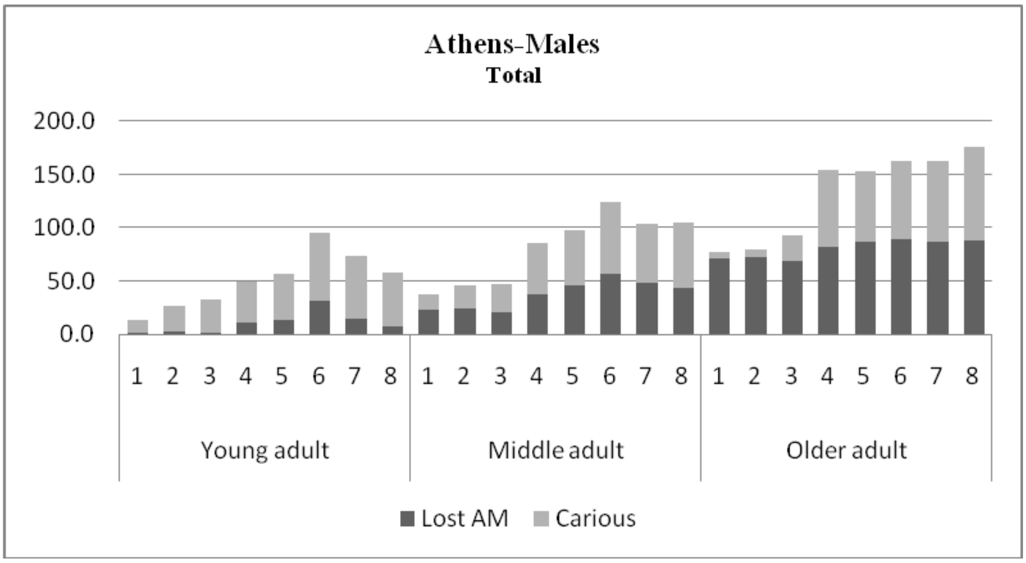

Figure 5.17c: Caries and antemortem tooth loss frequency rates for each tooth type (upper and lower dentition together), by age group, in males from Athens.

In the middle age group, dentine lesion frequencies were higher than those of pulp exposing lesions, whereas enamel caries rates were very low. In the oldest age group, lesions penetrating to the pulp chamber were by far the most common form and enamel lesions the least. Fillings' rates were lower than dentine and pulp lesions in young adults but more common than any other type of lesion, in the middle and older age groups.

Enamel lesions were rare in all age groups with the young being the most frequently affected by this type and the middle adults, the least. Pulp exposing lesion rates increased from the youngest to the middle adult age group but decreased in older individuals. Dentine lesions decreased with age. The highest percentages of fillings were observed in middle adults and the lowest in young individuals (Figs. 5.18a & 5.18b).

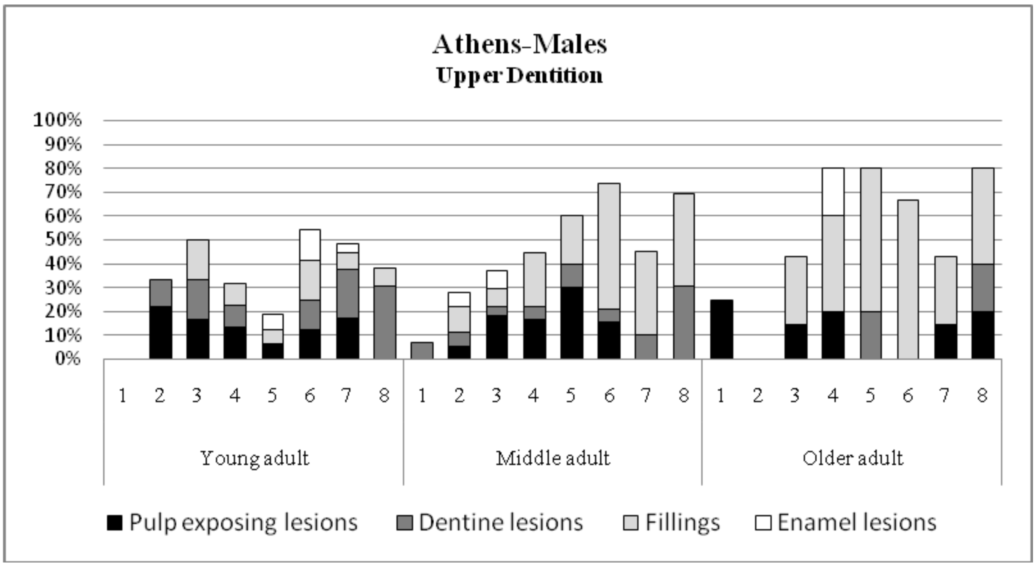

Figure 5.18a: Caries frequency rates for each tooth type (upper dentition), by age group, according to the severest lesion type on any surface of the tooth, in males from Athens.

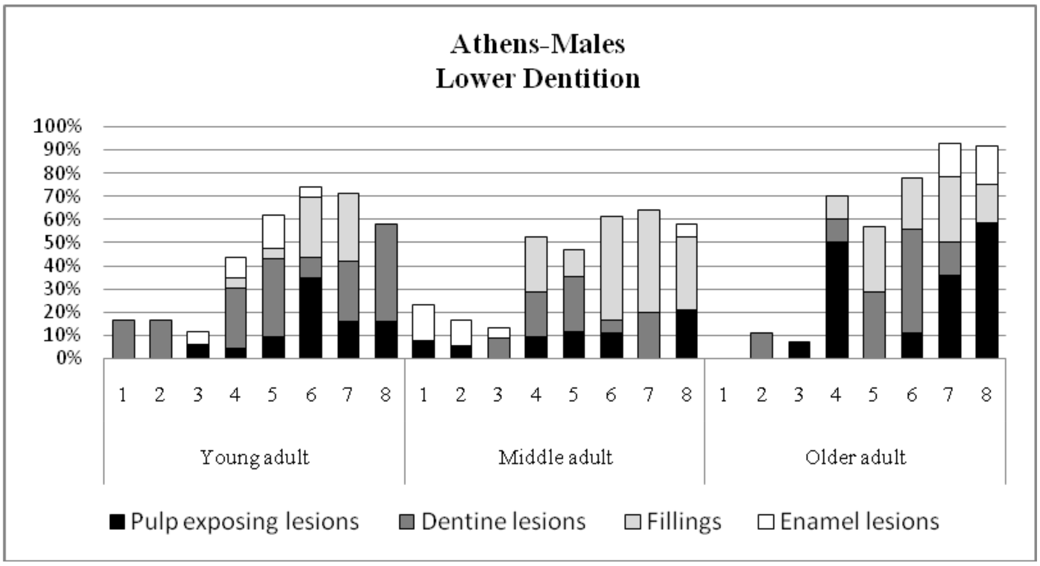

Figure 5.18b: Caries frequency rates for each tooth type (lower dentition), by age group, according to the severest lesion type on any surface of the tooth, in males from Athens.

Overall, pulp and dentine lesions, and fillings predominated in the posterior teeth. Enamel lesion rates were very similar between posterior and anterior teeth. When upper and lower dentitions were compared, pulp, dentine and enamel lesions were more common in mandibular teeth but fillings were more frequent in the maxillary dentition (Figs. 5.18a & 5.18b).

Similar were the patterns observed separately in each age group. Lesions penetrating to the pulp chamber, as well as dentine lesions and fillings, were predominant in the posterior teeth of all age groups. Pulp lesions more frequently affected the upper dentition of middle adults and the lower dentition of young and older adults. Enamel lesions were more common in the posterior teeth of young and older adults and the anterior teeth of middle adults. Both dentine and enamel lesions were more common in the mandibular teeth of all age groups Fillings' rates were higher in lower dentition of young individuals and in the upper dentition of middle and older adults (Figs. 5.18a & 5.18b).

Occlusal caries

Of all occlusal surfaces examined, 42.6% (193 / 453) showed evidence of occlusal caries. Molars (60.4%, 51.6%, 47.5% for first, second and third molars, respectively) were markedly more frequently affected than premolars (18.2% and 26.9% for first and second premolars, respectively). The teeth most affected were first molars (60.4%) and the teeth least affected were first premolars (18.2%). The rates of occlusal surface caries were higher in the lower (43.6%) than the upper (41.4%) teeth and steadily increased through age groups, from 38.9% in young adults to 42.7% in middle and 52.6% in older individuals.

Pit caries

Of all pit surfaces examined, 44.5% (154 / 346) showed evidence of pit caries. The percentages were much higher for molars (53.6%, 49.2% and 43.9% for first, second and third molars, respectively) than incisors (5.6% and 18.5% for first and second incisors). First molars were the most affected tooth type (53.6%) and first incisors the least affected (5.6%). The rates were higher in the lower (53.0%) than the upper (36.7%) teeth and decreased through the first two age groups from 45.9% in young to 41.2% in middle adults but rose to 48.4% in older individuals.

Occlusal attrition facet dentine caries

Of all occlusal attrition facets examined, 22.8% (156 / 683) showed evidence of occlusal attrition facet dentine caries. First molars were the most frequently affected tooth type (47.4%) and first incisors the least (3.6%). Posterior teeth were more frequently attacked by caries in the attrition facet, with percentages ranging from 15.2% to 47.4%, whereas the rates for first and second incisors, and canines were 3.6% 5.9% and 13.0%, respectively. The frequencies of caries were higher in the upper (25.0%) than the lower (21.1%) dentition and markedly increased with age, from 19.7% in young adults to 21.8% in the middle and 32.3% in the older individuals.

Contact caries

Of all contact areas between neighbouring teeth (mesial and distal) examined, 24.6% (346 / 1409) showed evidence of contact caries. First molars were the most frequently affected tooth type (42.0%) and canines the least (4.3%). In general, posterior teeth were markedly most frequently attacked by contact caries than anterior teeth. The percentages were slightly higher in the lower (24.1%) than the upper (24.9%) dentition and decreased from 24.1% in young to 21.9% in the middle adults but rose to 31.4% in older individuals.

Smooth surface caries

Of all smooth surfaces (buccal and lingual) examined, 15.2% (217 / 1425) showed evidence of smooth surface caries. First molars were the most frequently affected tooth type (27.0%) and first incisors the least (5.2%). Posterior teeth were more frequently affected than anterior. The percentages were slightly higher for the upper (15.3%) than the lower (15.1%) dentition and decreased from 13.6% in young adults to 13.5% in the middle but rose to 22.8% in older individuals.

Root surface caries

Of all root surfaces (mesial, distal, buccal and lingual) examined, 10.9% (309 / 2833) showed evidence of root surface caries. First molars were the most frequently affected tooth type (17.9%) and first incisors the least (5.2%). Posterior teeth were more frequently affected than anterior. The percentages were higher in the lower (11.7%) than the upper (9.9%) dentition and increased with age from 8.6% in young adults to 11.4% in the middle and 14.9% in the oldest group.

5.1.3 Within socioeconomic status groups

5.1.3.1 Demetrias

5.1.3.1.1 Low SES

Teeth examined and missing

The total number of observable tooth sockets for low SES in Demetrias was 2,702, of which, 198 (7.3%) teeth were lost antemortem, 446 (16.5%) were lost postmortem. Eruption problems were observed in 59 (2.2%) teeth. Overall, 1999 (74.0% of observable tooth sockets) were examined for the presence of carious lesions. The frequency rates of teeth present, lost antemortem and postmortem, and of those with eruption problems, regardless of age, are presented in Table 5.5a, and by age group, in Figures 5.19a and 5.19b for upper and lower dentition, respectively. In the youngest age group, a total of 79.4% of teeth was present. This number decreased in middle (72.8%) and older individuals (53.3%). AMTL steadily increased from 2.1% in young adults to 9.1% in the middle and 16.3% in the older age group. The most frequently missing tooth class were first molars, and first molars of older adults (30.8%) in particular, whereas canines were the least frequently affected tooth class, with none of canines of young adults lost antemortem. AMTL was generally more common in posterior teeth. The opposite was the case for PMTL, in all three age groups (Figs. 5.19a & 5.19b).

First incisors were the most frequently missing (PMTL) tooth type (36.4%, 42.9% and 45.5%, for young, middle and older individuals, respectively) and first molars the least (3.0%, 4.7% and 7.7%, for young, middle and older individuals, respectively). The frequency of teeth present was higher in the maxilla in all age groups. Mandibular teeth suffered AMTL more frequently than maxillary teeth in all three age classes (Figs. 5.19a & 5.19b). Upper teeth of young and older

Tooth Type		Present	Lost AM	Lost PM	Eruption Problems	Total
1	**N**	168	13	127	1	**309**
	%	54.4%	4.2%	41.1%	.3%	**100.0%**
2	**N**	203	11	109	0	**323**
	%	62.8%	3.4%	33.7%	.0%	**100.0%**
3	**N**	281	6	66	1	**354**
	%	79.4%	1.7%	18.6%	.3%	**100.0%**
4	**N**	285	14	46	0	**345**
	%	82.6%	4.1%	13.3%	.0%	**100.0%**
5	**N**	276	36	33	0	**345**
	%	80.0%	10.4%	9.6%	.0%	**100.0%**
6	**N**	289	63	16	0	**368**
	%	78.5%	17.1%	4.3%	.0%	**100.0%**
7	**N**	306	32	16	0	**354**
	%	86.4%	9.0%	4.5%	.0%	**100.0%**
8	**N**	191	23	33	57	**304**
	%	62.8%	7.6%	10.9%	18.8%	**100.0%**
Total	**N**	**1999**	**198**	**446**	**59**	**2702**
	%	**74.0%**	**7.3%**	**16.5%**	**2.2%**	**100.0%**

Table 5.5a: Number and percentages of teeth present, missing antemortem, lost postmortem, and with eruption related problems in each tooth type (upper and lower together), regardless of age, in the low SES group from Demetrias.

adults were lost postmortem more often than lower, whereas the opposite was the case for middle adults. Eruption problems were much more common in mandibular teeth in all age classes (Figs. 5.19a & 5.19b).

Caries

In the low SES population from Demetrias, 3.9% (79 / 2006) of the permanent teeth and 35.9% (46 / 128) of individuals with surviving teeth were affected by caries. When only cavitated lesions were considered, the first figure decreased to 3.7% (74 / 2006), whereas the second remained the same (35.9%, 46 / 128). Of 128 low SES individuals with dentitions, only 8 (6.3%) had only one decayed tooth.

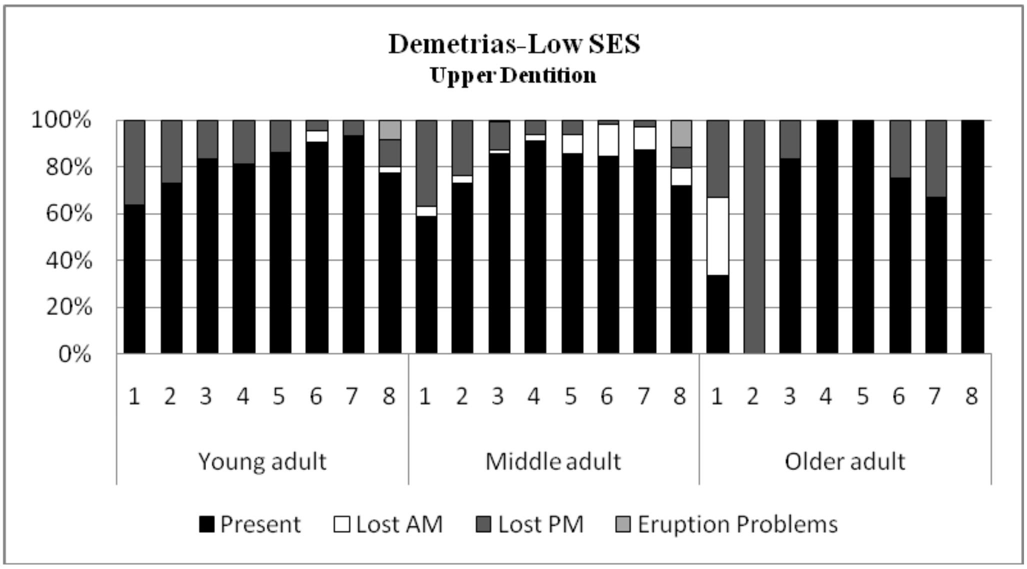

Figure 5.19a: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (upper dentition), by age group, in the low SES group from Demetrias.

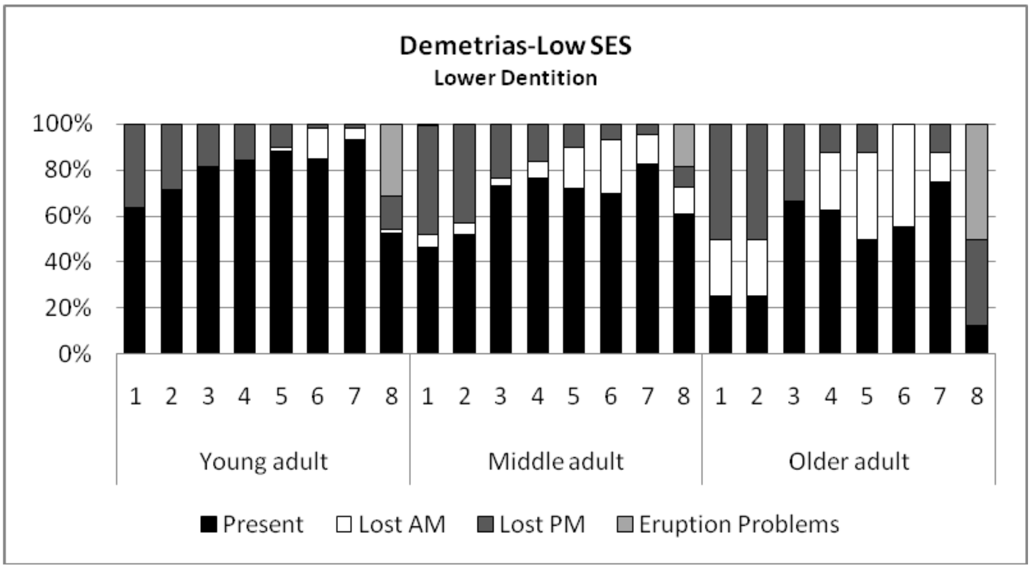

Figure 5.19b: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (lower dentition), by age group, in the low SES group from Demetrias.

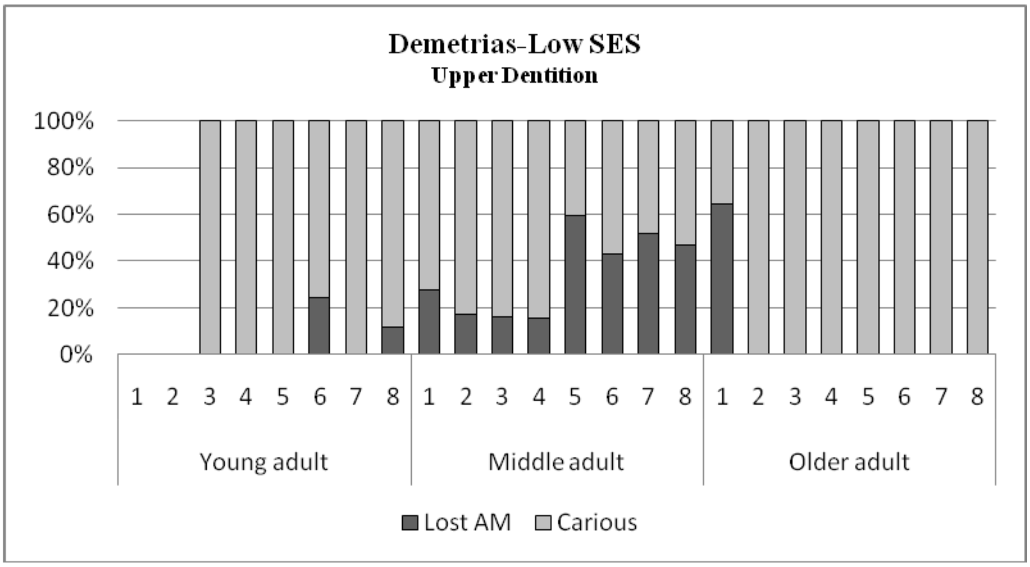

Figure 5.20a: Caries and antemortem tooth loss frequency rates for each tooth type (upper dentition), by age group, in the low SES group from Demetrias.

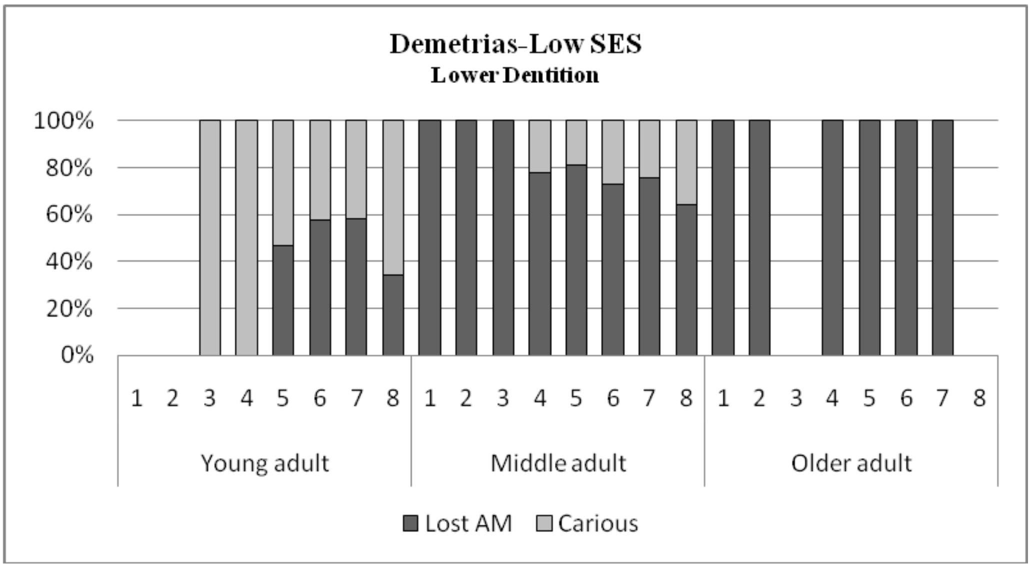

Figure 5.20b: Caries and antemortem tooth loss frequency rates for each tooth type (lower dentition), by age group, in the low SES group from Demetrias.

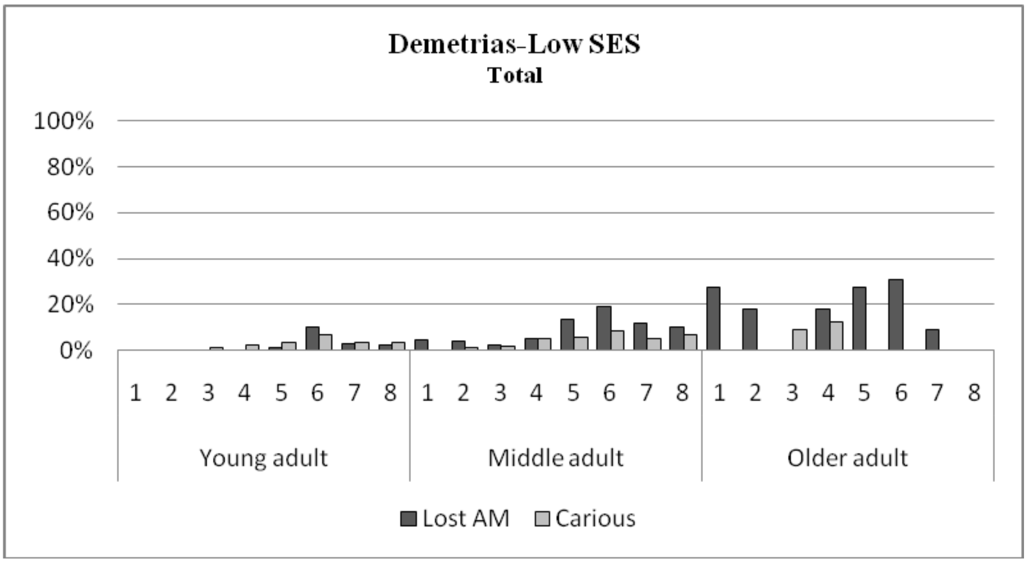

Figure 5.20c: Caries and antemortem tooth loss frequency rates for each tooth type (upper and lower dentition together), by age group, in the low SES group from Demetrias.

Gross cavities, in at least one tooth, were observed in 25% (32 / 128) of low SES individuals.

In Figures 5.20a, 5.20b and 5.20c, AMTL and caries rates, on any tooth surface and regardless of lesion type, are presented for each tooth type by age group. In the younger age group, 2.8% of all teeth were carious. This increased to 4.5% in middle adults and again decreased to 4.1% in the older individuals. The rates of AMTL were 2.1% in the young, 9.1% in the middle and 16.3% in the older individuals. Posterior teeth were affected by both caries and AMTL more often than anterior teeth. Carious lesions, as well as AMTL, attacked upper more frequently than lower dentitions. The most frequently involved teeth (upper and lower together) were first molars for both caries (7.6%) and AMTL (17.1%).

In Figures 5.21a and 5.21b, caries frequency rates are presented for each tooth type by age group in low SES individuals, according to the severest lesion type on any surface of the tooth. Dentine and pulp lesions equally affected the teeth of young adults and were the most common form in this age group. In the middle age group, pulp exposing lesion frequencies were higher than those of dentine and enamel caries. Lesions penetrating to the pulp chamber were the only form observed in the oldest group.

Enamel lesions were rare in the first two age groups with middle adults being the most frequently affected age group; lesions of this form were not observed in older adults. Pulp exposing lesion rates steadily increased with age. Dentine lesion rates increased from the youngest to the middle adult age group, whereas older individuals were not affected by this form. Overall, pulp and dentine lesions predominated in the posterior teeth, particularly molars, whereas enamel lesions were more common in premolars than any other tooth type. When upper and lower dentitions were compared, pulp and dentine lesions were higher in the former, whereas lesions confined to the enamel were more common in mandibular teeth (Figs. 5.21a and 5.21b).

Similar were the patterns observed separately in each age group. Pulp and dentine lesions were predominant in the posterior teeth of all age groups. Enamel lesions were more frequent in the anterior teeth of young individuals and the posterior teeth of middle adults. Pulp lesions more frequently affected the upper dentition of middle and older individuals and the lower dentition of young adults. Dentine lesions were more common in the upper dentition of young and middle adults, whereas in older individuals, neither the upper nor the lower teeth were affected. Mandibular teeth showed higher rates of enamel

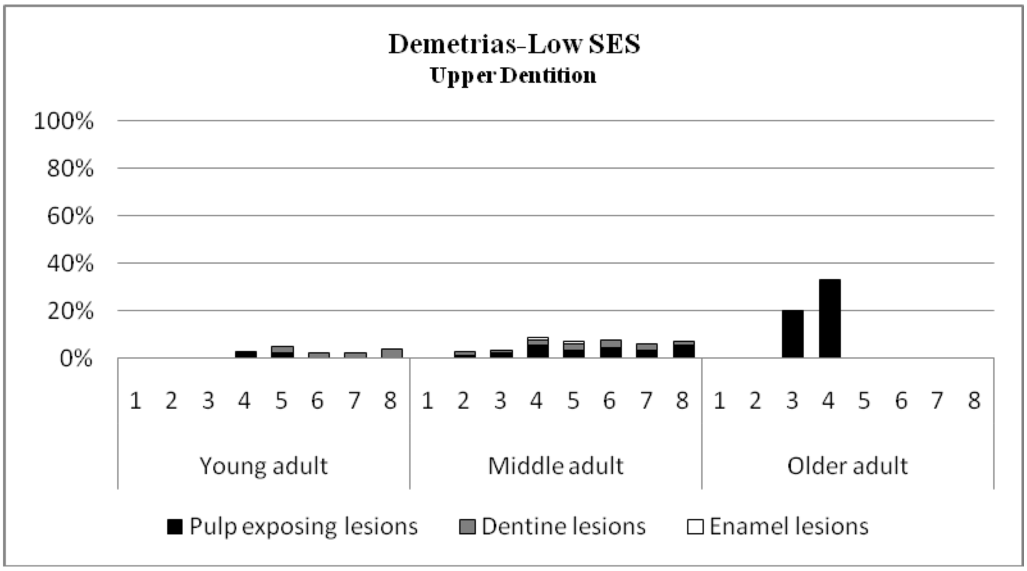

Figure 5.21a: Caries frequency rates for each tooth type (upper dentition), by age group, according to the severest lesion type on any surface of the tooth, in the low SES group from Demetrias.

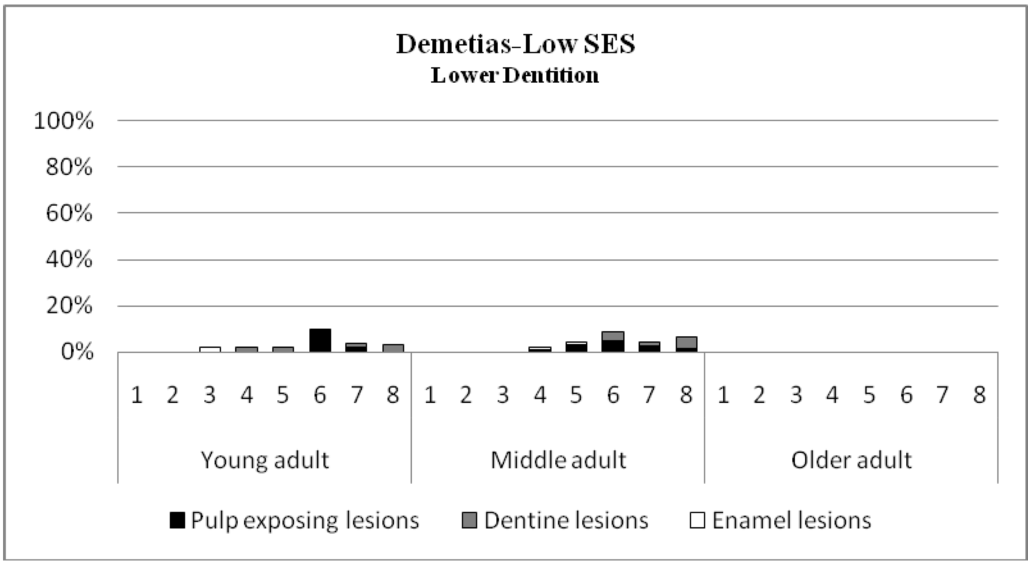

Figure 5.21b: Caries frequency rates for each tooth type (lower dentition), by age group, according to the severest lesion type on any surface of the tooth, in the low SES group from Demetrias.

caries in young individuals but equally affected the upper and lower dentition of middle adults; older adults were not affected (Figs. 5.21a and 5.21b

Occlusal caries

Of all occlusal surfaces examined, 3.0% (39 / 1321) showed evidence of occlusal caries. Molars (4.3%, 2.7% and 3.7% for first, second and third molars, respectively) were more frequently affected than premolars (2.2% and 2.2% for first and second premolars, respectively). The teeth most affected were first molars (4.3%) and the teeth least affected were first and second premolars (2.2%). The rates of occlusal surface caries were higher in the upper (3.1%) than the lower (2.8%) teeth and increased from 1.7% in young adults to 3.5% in middle adults and decreased to 3.0% in older individuals.

Pit caries

The frequency of pit caries (3.3% - 31 / 930) was higher than that of occlusal surface caries. The percentages were markedly higher for molars (4.0%, 3.0% and 5.3% for first, second and third molars, respectively) than incisors (0.0% and 1.1% for first and second incisors). Third molars were the most affected tooth type and first incisors the least affected. The rates were higher in the lower (4.6%) than the upper (2.2%) teeth and increased steadily through the first two age groups from 3.2% in young to 3.5% in middle adults but decreased to 0.0% in older individuals.

Occlusal attrition facet caries

Of all occlusal attrition facets examined, 1.9% (39 / 2003) showed evidence of occlusal attrition facet dentine caries. First molars were the most frequently affected tooth type (4.5%) and first incisors the least (0.0%). Posterior teeth were more frequently attacked by caries in the attrition facet than anterior teeth. The frequencies of caries were higher in the upper (2.4%) than the lower (1.6%) dentition and markedly increased with age, from 1.0% in young adults to 2.3% in the middle and 4.1% in the older individuals.

Contact caries

Of all contact areas between neighbouring teeth (mesial and distal) examined, 2.1% (85 / 3959) showed evidence of contact caries. First molars were the most frequently affected tooth type (4.4%) and first incisors the least (0.0%). In general, posterior teeth were markedly most frequently attacked by contact caries than anterior teeth. The percentages were higher in the upper (2.9%) than the lower (1.6%) dentition and increased as age progressed, from 1.2% in young adults to 2.5% in the middle and 4.1% in older individuals.

Smooth surface caries

Of all smooth surfaces (buccal and lingual) examined, 1.4% (54 / 3962) showed evidence of smooth surface caries. First molars were the most frequently affected tooth type (2.3%) and first incisors the least (0.0%). Posterior teeth were more frequently affected than anterior. The percentages were higher for the upper (1.9%) than the lower (1.0%) dentition and steadily increased with age, from 0.7% in the young adults to 1.6% in middle and 4.1% in older individuals.

Root surface caries

Of all root surfaces (mesial, distal, buccal and lingual) examined, 1.9% (151 / 7982) showed evidence of root surface caries. First molars were the most frequently affected tooth type (3.5%) and first incisors the least (0.0%). Posterior teeth were more frequently affected than anterior. The percentages were higher in the upper (2.4%) than the lower (1.5%) dentition and increased with age from 0.7% in young adults to 2.4% in the middle and 4.1% in the oldest group.

5.1.3.1.2 High SES

Teeth examined and missing

The total number of observable tooth sockets for high SES in Demetrias was 2,298, of which, 174 (7.6%) teeth were lost antemortem, 277 (12.1%) were lost postmortem. Eruption problems were observed in 50 (2.2%) teeth. Overall, 1797 (78.2% of observable tooth sockets) were examined for the presence of carious lesions. The frequency rates of teeth present, lost antemortem and postmortem, and of those with eruption problems, regardless of age, are presented in Table 5.5b, and by age group, in Figures 5.22a and 5.22b and for upper and lower dentition, respectively. The most frequently missing tooth class were first molars, and first molars of older adults (36.4%) in particular, whereas canines of young adults were the least frequently missing, with none of them lost antemortem. AMTL was generally more common in posterior teeth. First incisors were the most frequently missing (PMTL) tooth type (29.8%, 35.2% and 17.9%, for young, middle and older individuals, respectively) and first molars the least (0.0%, 2.4% and 1.5%, for young, middle and older individuals, respectively). The frequency of teeth present was higher in the maxilla in the first two age groups but lower in the older group (Figs. 5.22a and 5.22b).

Tooth Type		Present	Lost AM	Lost PM	Eruption Problems	Total
1	**N**	188	9	84	0	**281**
	%	66.9%	3.2%	29.9%	.0%	**100.0%**
2	**N**	197	9	71	0	**277**
	%	71.1%	3.2%	25.6%	.0%	**100.0%**
3	**N**	269	6	40	0	**315**
	%	85.4%	1.9%	12.7%	.0%	**100.0%**
4	**N**	264	11	26	0	**301**
	%	87.7%	3.7%	8.6%	.0%	**100.0%**
5	**N**	238	30	25	0	**293**
	%	81.2%	10.2%	8.5%	.0%	**100.0%**
6	**N**	233	56	4	0	**293**
	%	79.5%	19.1%	1.4%	.0%	**100.0%**
7	**N**	238	32	8	4	**282**
	%	84.4%	11.3%	2.8%	1.4%	**100.0%**
8	**N**	170	21	19	46	**256**
	%	66.4%	8.2%	7.4%	18.0%	**100.0%**
Total	**N**	**1797**	**174**	**277**	**50**	**2298**
	%	**78.2%**	**7.6%**	**12.1%**	**2.2%**	**100.0%**

Table 5.5b: Number and percentages of teeth present, missing antemortem, lost postmortem, and with eruption related problems in each tooth type (upper and lower together), regardless of age, in the high SES group from Demetrias.

Mandibular teeth suffered AMTL more frequently than maxillary teeth in the two younger age classes but less frequently in the third one. Upper teeth of young and older adults were lost postmortem more often than lower, whereas the opposite was the case for middle adults (Figs. 5.22a and 5.22b). Eruption problems were much more common in the mandibular teeth of young individuals and in the maxillary teeth of middle and older individuals (Figs. 5.22a and 5.22b).

<u>Caries</u>

In the high SES population from Demetrias, 13.9% (249 / 1790) of the permanent teeth and 56.4% (62 / 110) of individuals with surviving teeth were affected by

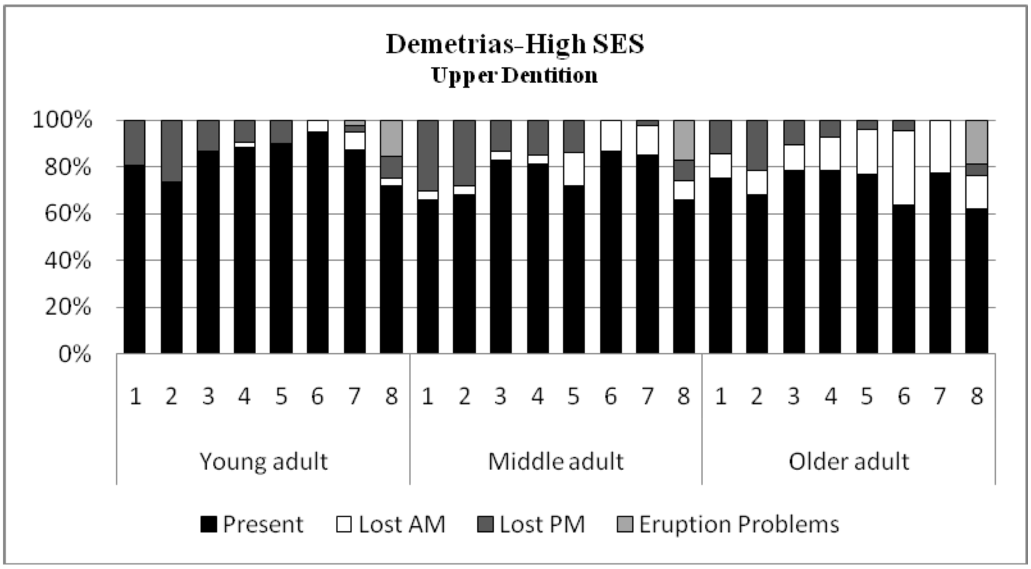

Figure 5.22a: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (upper dentition), by age group, in the high SES group from Demetrias.

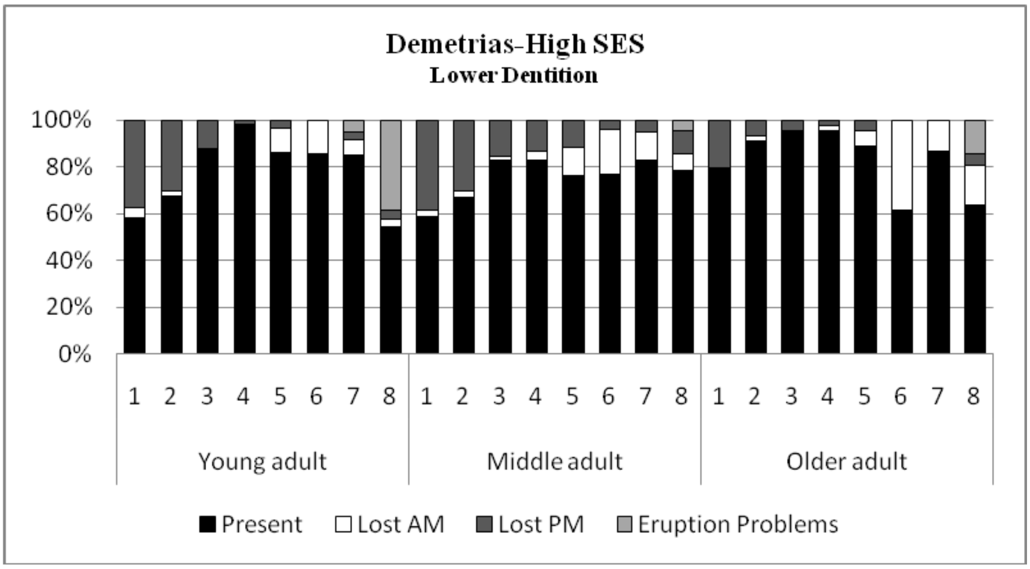

Figure 5.22b: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (lower dentition), by age group, in the high SES group from Demetrias.

caries. When only cavitated lesions were considered, these figures decreased to 11.8% (211 / 1790) and 52.7% (58 / 110), respectively. Of 110 high SES individuals with dentitions, only 8 (7.3%) had only one decayed tooth. Gross cavities, in at least one tooth, were observed in 25.5% (28 / 110) of high SES individuals.

In Figures 5.23a, 5.23b and 5.23c, AMTL and caries rates, on any tooth surface and regardless of lesion type, are presented for each tooth type by age group. In the younger age group, 10.8% of all teeth were carious. This increased to 11.5% in middle adults and 22.1% in the older individuals. The rates of AMTL were 4.1% in the young, 7.6% in the middle and 12.4% in the older individuals. Posterior teeth were affected by both caries and AMTL more often than anterior teeth. Carious lesions, as well as AMTL, attacked upper more frequently than lower dentitions. The most frequently involved teeth (upper and lower together) were first molars for both caries (20.9%) and AMTL (19.1%).

In Figures 5.24a and 5.24b, caries frequency rates are presented for each tooth type by age group in high SES individuals, according to the severest lesion type on any surface of the tooth. Dentine lesions were the most common form in young adults, followed by enamel and pulp lesions. In the middle age group, dentine lesion frequencies were higher than those of pulp exposing lesions, whereas enamel lesions were very low. The same pattern was observed in the older age class. Enamel lesions were rare in all age groups with young adults being the most frequently affected age group Figs. 5.24a and 5.24b. Pulp exposing and dentine lesion rates steadily increased with age. Overall, pulp and dentine lesions predominated in the posterior teeth, particularly molars, whereas enamel lesion rates were very similar between anterior and posterior teeth Figs. 5.24a and 5.24b. When upper and lower dentitions were compared, pulp and

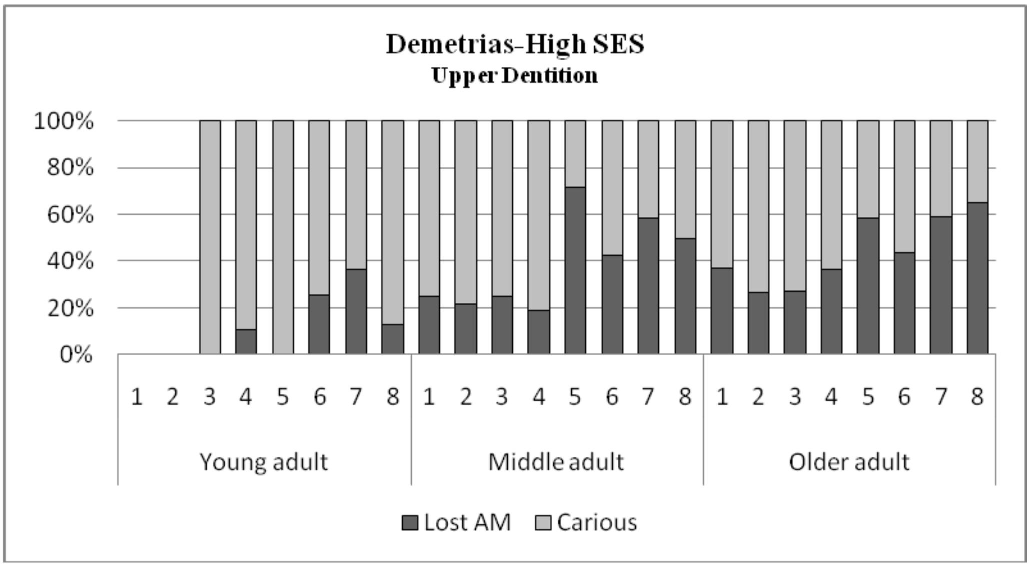

Figure 5.23a: Caries and antemortem tooth loss frequency rates for each tooth type (upper dentition), by age group, in the high SES group from Demetrias.

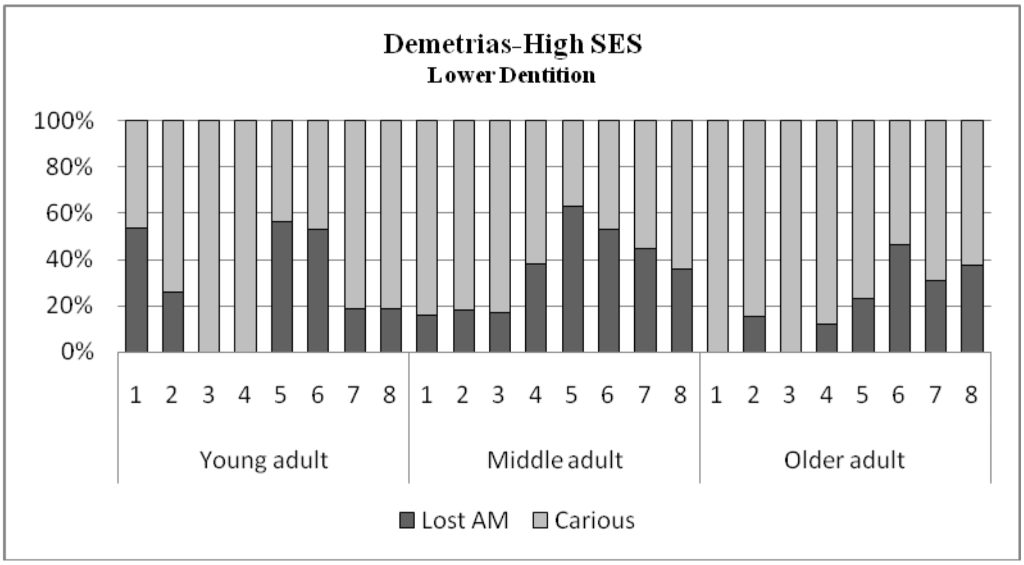

Figure 5.23b: Caries and antemortem tooth loss frequency rates for each tooth type (lower dentition), by age group, in the high SES group from Demetrias.

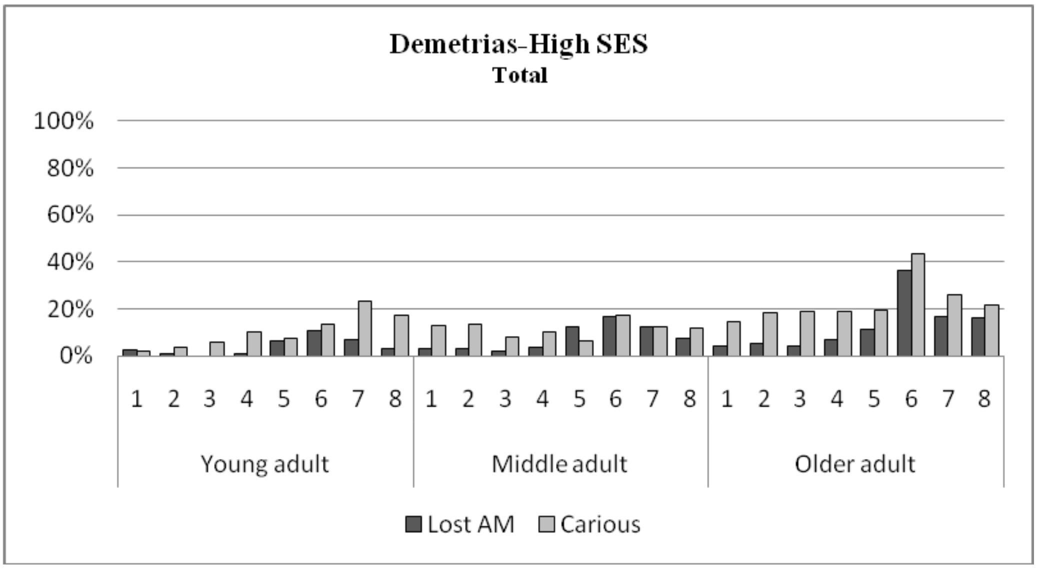

Figure 5.23c: Caries and antemortem tooth loss frequency rates for each tooth type (upper and lower dentition together), by age group, in the high SES group from Demetrias.

dentine lesions were higher in the former, whereas lesions confined to the enamel were more common in mandibular teeth (Figs. 5.24a and 5.24b).

Similar were the patterns observed separately in each age group. Pulp and dentine lesions were predominant in the posterior teeth of all age groups(Figs. 5.24a and 5.24b). Enamel lesion rates were higher in the posterior teeth of young and older individuals and the anterior teeth of middle adults. Pulp lesions more frequently affected the upper dentition of young and middle individuals and the lower dentition of older adults(Figs. 5.24a and 5.24b). Dentine lesions were more common in the upper teeth of young and older age groups and in the lower teeth of middle adults, whereas enamel caries in mandibular teeth of all age groups(Figs. 5.24a and 5.24b).

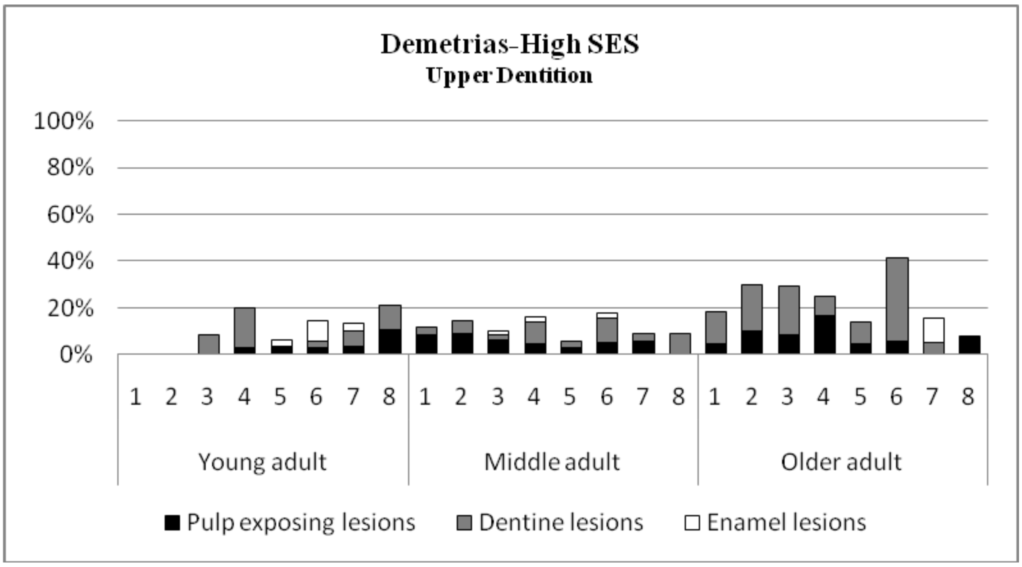

Figure 5.24a: Caries frequency rates for each tooth type (upper dentition), by age group, according to the severest lesion type on any surface of the tooth, in the high SES group from Demetrias.

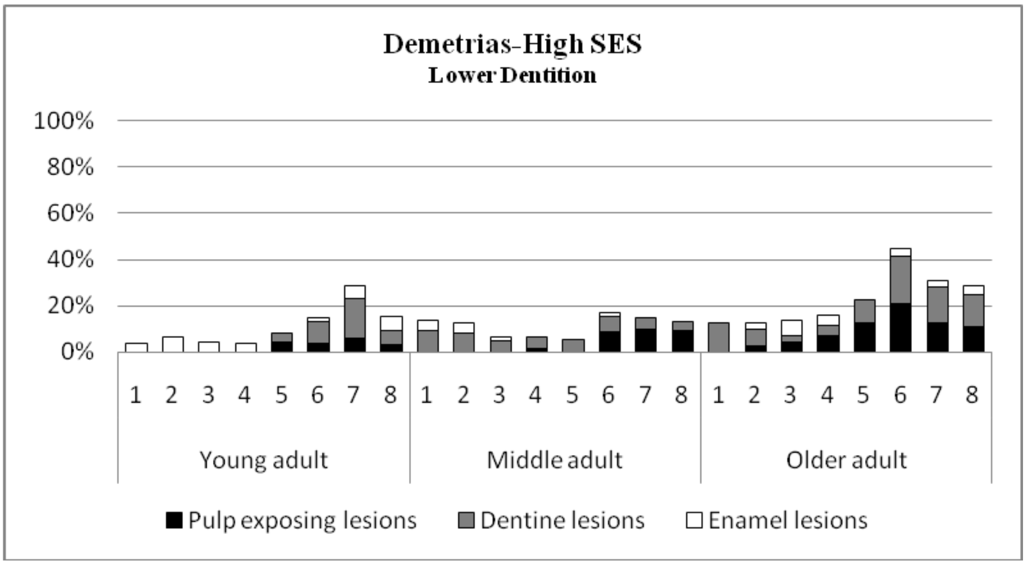

Figure 5.24b: Caries frequency rates for each tooth type (lower dentition), by age group, according to the severest lesion type on any surface of the tooth, in the high SES group from Demetrias.

Occlusal caries

Of all occlusal surfaces examined, 5.6% (62 / 1112) showed evidence of occlusal caries. Molars (6.1%, 7.7% and 6.0% for first, second and third molars, respectively) were markedly more frequently affected than premolars (4.0% and 4.4% for first and second premolars, respectively). The teeth most affected were second molars (7.7%) and the teeth least affected were first premolars (4.0%). The rates of occlusal surface caries were higher in the lower (5.9%) than the upper (4.9%) teeth and increased from 4.1% in young adults to 5.1% in middle and 8.8% in older individuals.

Pit caries

The frequency of pit caries (5.0% - 38 / 763) was lower than that of occlusal surface caries. The percentages were higher for incisors (5.6% and 7.6% for first and second incisors) than molars (4.4%, 5.6% and 3.6% for first, second and third molars, respectively). Second premolars were the most affected tooth type and third molars the least affected. The rates were higher in the lower (5.9%) than the upper (3.9%) teeth and increased steadily through the first two age groups from 3.4% in young to 6.4% in middle adults but decreased to 4.7% in older individuals.

Occlusal attrition facet caries

Of all occlusal attrition facets examined, 6.9% (123 / 1771) showed evidence of occlusal attrition facet dentine caries. First molars were the most frequently affected tooth type (11.3%) and canines the least (3.4%). Posterior teeth were more frequently attacked by caries in the attrition facet than anterior teeth. The frequencies of caries were higher in the upper (7.2%) than the lower (6.8%)

dentition and markedly increased with age, from 2.9% in young adults to 7.6% in the middle and 11.3% in the older individuals.

Contact caries

Of all contact areas between neighbouring teeth (mesial and distal) examined, 4.7% (160 / 3400) showed evidence of contact caries. Second premolars were the most frequently affected tooth type (5.8%) and canines the least (2.7%). In general, posterior teeth were most frequently attacked by contact caries than anterior teeth. The percentages were slightly higher in the lower (5.1%) than the upper (4.1%) dentition and steadily increased with age, from 2.1% in young adults to 5.0% in middle and 8.0% in older individuals.

Smooth surface caries

Of all smooth surfaces (buccal and lingual) examined, 3.8% (135 / 3509) showed evidence of smooth surface caries. Second incisors were the most frequently affected tooth type (6.6%) and canines the least (1.9%). Anterior teeth were more frequently affected than posterior. The percentages were higher for the lower (4.7%) than the upper (2.5%) dentition and increased as age progressed, from 0.7% in young adults to 4.4% in middle and 7.1% in older individuals.

Root surface caries

Of all root surfaces (mesial, distal, buccal and lingual) examined, 5.3% (367 / 6873) showed evidence of root surface caries. First molars were the most frequently affected tooth type (6.9%) and canines the least (3.7%). Posterior teeth were almost as frequently affected as anterior teeth. The percentages were higher in the lower (6.6%) than the upper (3.3%) dentition and increased with age from 3.7% in young adults to 4.7% in the middle and 8.9% in the oldest group.

5.1.3.2 Athens

5.1.3.2.1 Low SES

Teeth examined and missing

The total number of observable tooth sockets for low SES in Athens was 1136, of which, 513 (45.2%) teeth were lost antemortem, 328 (28.9%) were lost postmortem. Eruption problems were observed in 18 (1.6%) teeth. Overall, 277 (24.4% of observable tooth sockets) were examined for the presence of carious lesions. The frequency rates of teeth present, lost antemortem and postmortem, and of those with eruption problems, regardless of age, are presented in Table 5.6a, and by age group, in Figures 5.25a and 5.25b for upper and lower dentition, respectively. The most frequently missing tooth class were first molars, and first molars of older adults (92.6%) in particular, whereas first incisors were the least frequently missing, with none of first incisors of young adults lost antemortem. AMTL was generally more common in posterior teeth. First incisors were the most frequently missing (PMTL) tooth type (67.6%, 56.6% and 27.8%, for young, middle and older individuals, respectively) and first molars the least (5.9%, 29.6% and 3.7%, for young, middle and older individuals, respectively). The frequency of teeth present was higher in the lower dentition in the first two age groups but lower in the older group (Figs. 5.25a and 5.25b). Maxillary teeth suffered both AMTL and PMTL more frequently than mandibular teeth in all age groups. Eruption problems were much more common in the maxillary teeth of young and middle individuals; no eruption problems were observed in the older age group (Figs. 5.25a and 5.25b).

Tooth Type		Present	Lost AM	Lost PM	Eruption Problems	Total
1	**N**	27	46	68	0	**141**
	%	19.1%	32.6%	48.2%	.0%	**100.0%**
2	**N**	31	47	63	0	**141**
	%	22.0%	33.3%	44.7%	.0%	**100.0%**
3	**N**	38	47	56	0	**141**
	%	27.0%	33.3%	39.7%	.0%	**100.0%**
4	**N**	37	71	35	0	**143**
	%	25.9%	49.7%	24.5%	.0%	**100.0%**
5	**N**	27	76	39	0	**142**
	%	19.0%	53.5%	27.5%	.0%	**100.0%**
6	**N**	36	86	20	0	**142**
	%	25.4%	60.6%	14.1%	.0%	**100.0%**
7	**N**	44	76	22	1	**143**
	%	30.8%	53.1%	15.4%	.7%	**100.0%**
8	**N**	37	64	25	17	**143**
	%	25.9%	44.8%	17.5%	11.9%	**100.0%**
Total	**N**	**277**	**513**	**328**	**18**	**1136**
	%	**24.4%**	**45.2%**	**28.9%**	**1.6%**	**100.0%**

Table 5.6a: Number and percentages of teeth present, missing antemortem, lost postmortem, and with eruption related problems in each tooth type (upper and lower together), regardless of age, in the low SES group from Athens.

<u>Caries</u>

In the low SES population from Athens, 45.7% (128 / 280) of the permanent teeth and 95.0% (19 / 20) of individuals with surviving teeth were affected by caries. When only cavitated lesions were considered, the first figure decreased to 42.1% (118 / 280), whereas the second remained the same (95.0%, 19 / 20). None (0.0%) of the 20 low SES individuals with dentitions had one decayed tooth only. Gross cavities, in at least one tooth, were observed in 50.0% (10 / 20) of low SES individuals. It should be noted that all the above figures, except the last one (gross cavities), include fillings.

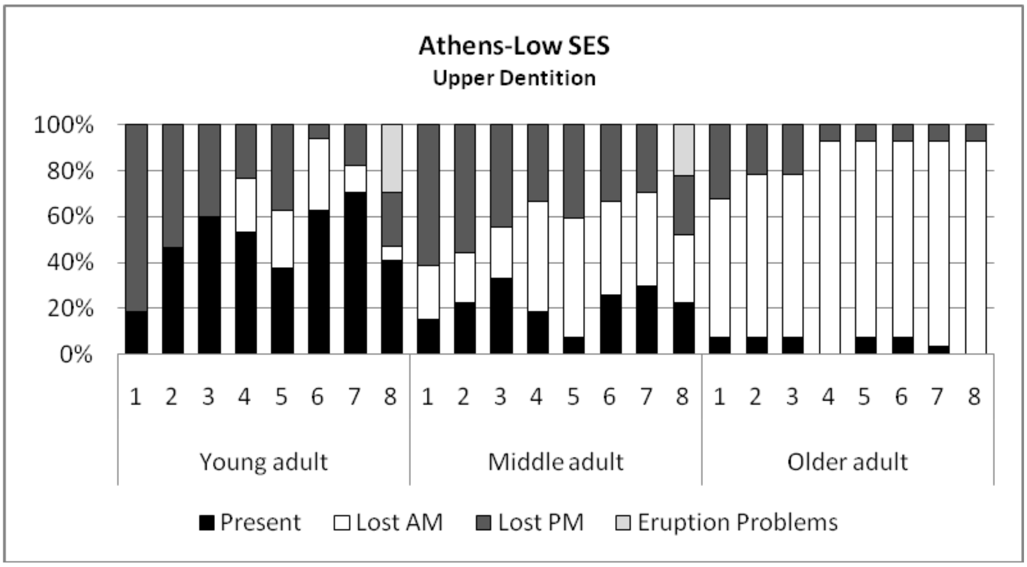

Figure 5.25a: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (upper dentition), by age group, in the low SES group from Athens.

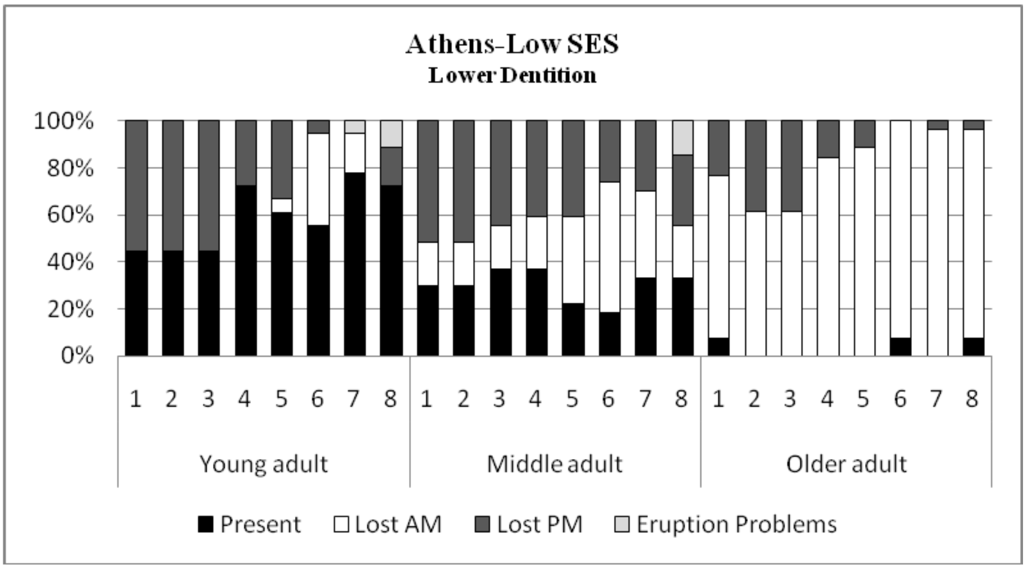

Figure 5.25b: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (lower dentition), by age group, in the low SES group from Athens.

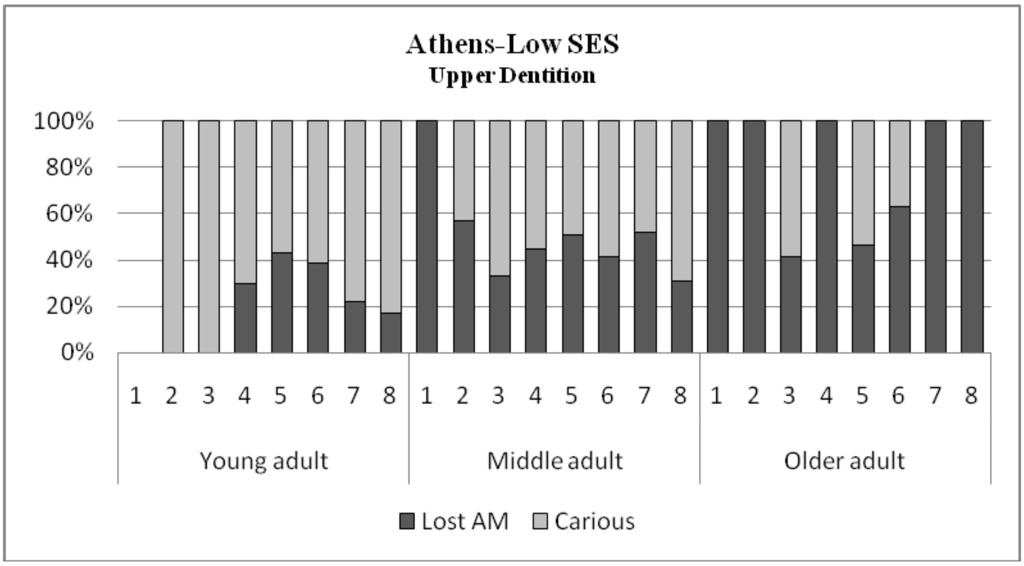

Figure 5.26a: Caries and antemortem tooth loss frequency rates for each tooth type (upper dentition), by age group, in the low SES group from Athens.

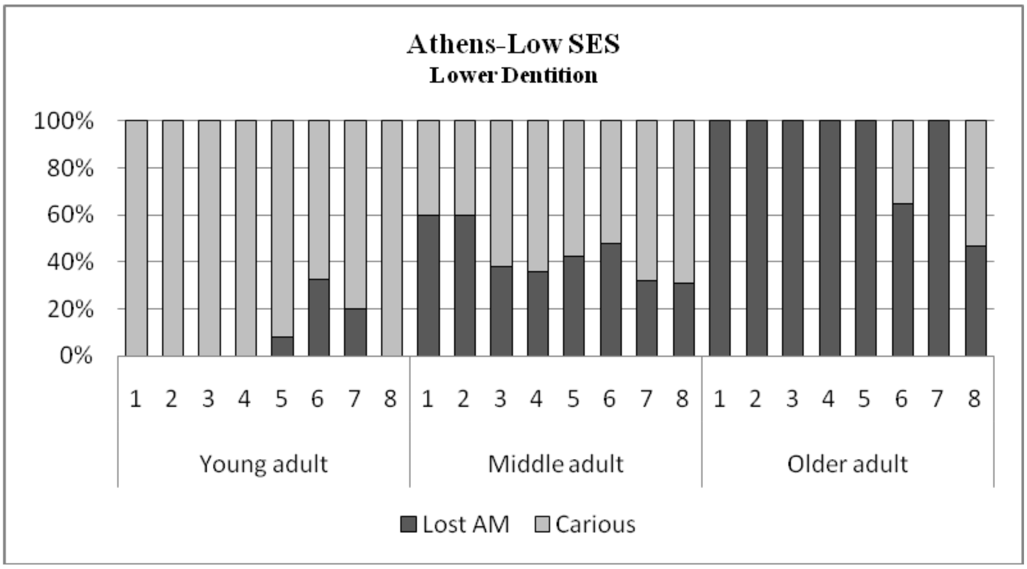

Figure 5.26b: Caries and antemortem tooth loss frequency rates for each tooth type (lower dentition), by age group, in the low SES group from Athens.

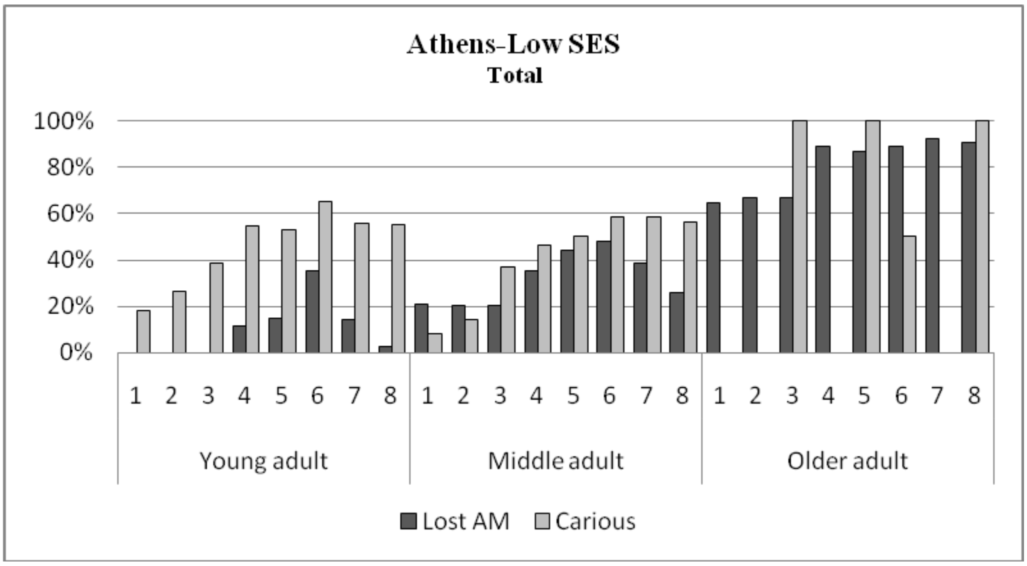

Figure 5.26c: Caries and antemortem tooth loss frequency rates for each tooth type (upper and lower dentition together), by age group, in the low SES group from Athens.

In Figures 5.26a, 5.26b and 5.26c, AMTL and caries rates, on any tooth surface and regardless of lesion type, are presented for each tooth type by age group. In the younger age group, 48.7% of all teeth were carious. This decreased to 41.6% in middle adults and again increased to 47.1% in the older individuals. The rates of AMTL were 9.9% in the young, 31.8% in the middle and 80.8% in the older individuals. Posterior teeth were affected by both caries and AMTL more often than anterior teeth (Figs. 5.26a, 5.26b and 5.26c). Carious lesions attacked lower more frequently than upper dentitions, whereas the opposite was the case for AMTL (Figs. 5.26a, 5.26b and 5.26c). The most frequently involved teeth (upper and lower together) were first molars for both caries (61.1%) and AMTL (60.6%).

In Figures 5.27a and 5.27b, caries frequency rates are presented for each tooth type by age group in low SES individuals, according to the severest lesion type on any surface of the tooth. Dentine lesions were the most common form in young adults, followed by fillings, pulp and enamel lesions(Figs. 5.27a and

5.27b). Dentine and pulp exposing caries frequencies equally affected middle adults and were higher than those of enamel caries (Figs. 5.27a and 5.27b). In the oldest age group, enamel lesions were the most frequently obsrved form, followed by dentine lesions, whereas no pulp lesions were recorded. Fillings' rates were very high and markedly more common than any other type of lesion in both middle and older individuals (Figs. 5.27a and 5.27b).

Enamel lesions were rare in the first two age groups with middle adults being the most frequently affected age group; lesions of this form were not observed in older adults. Pulp exposing lesion and fillings rates steadily increased with age, whereas dentine lesion rates steadily decreased as age progressed (Figs. 5.27a and 5.27b). Overall, pulp lesions predominated in the posterior teeth, particularly premolars, but second incisors and canines were slightly more often affected than molars. Dentine lesions and fillings were markedly more common in posterior teeth. Enamel lesion rates were very more frequent in posterior teeth than incisors but canines were the most commonly affected tooth type. When upper and lower dentitions were compared, pulp lesions and fillings were higher in the former, whereas lesions penetrating to the dentine and those confined to the enamel were more common in mandibular teeth (Figs. 5.27a and 5.27b).

Similar were the patterns observed separately in each age group. Pulp and dentine lesions were predominant the posterior teeth of all age groups. Fillings' rates were higher in the posterior teeth in the first two age classes but in the older age group, canines and posterior teeth were equally affected. Enamel caries affected the posterior teeth of young and older individuals, and the anterior teeth of middle adults. Pulp lesions more frequently attacked the upper

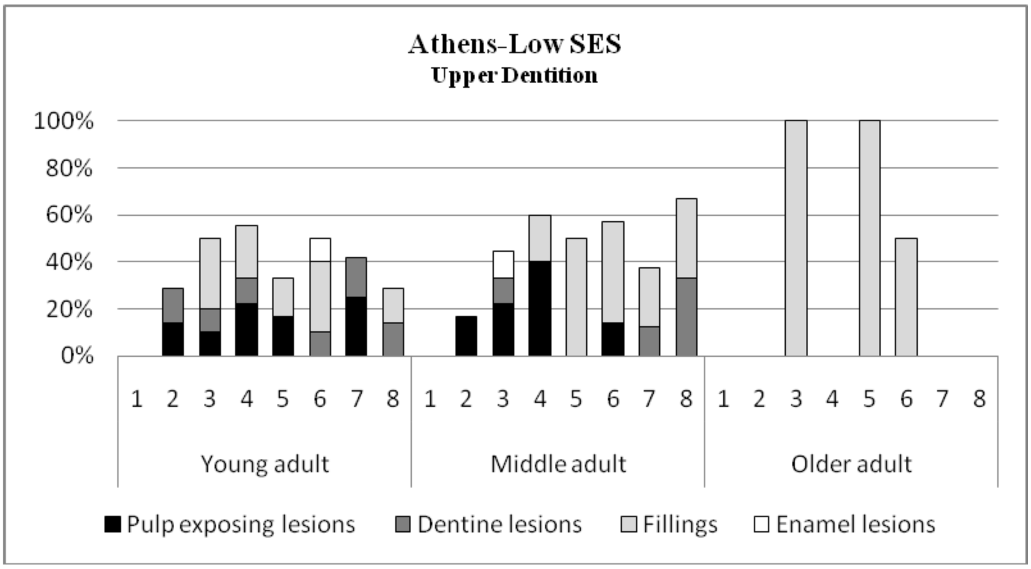

Figure 5.27a: Caries frequency rates for each tooth type (upper dentition), by age group, according to the severest lesion type on any surface of the tooth, in the low SES group from Athens.

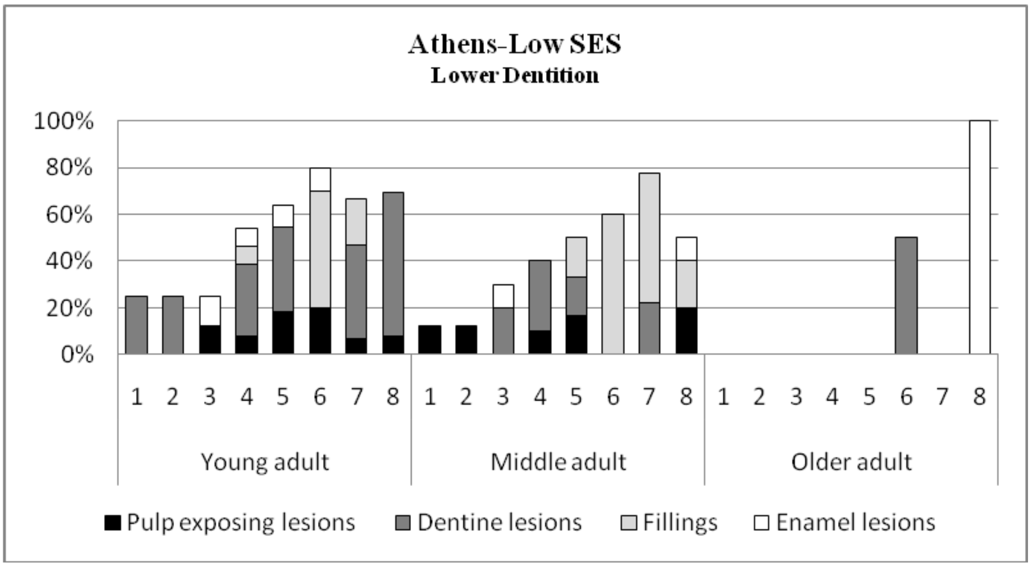

Figure 5.27b: Caries frequency rates for each tooth type (lower dentition), by age group, according to the severest lesion type on any surface of the tooth, in the low SES group from Athens.

dentition of young and middle individuals, whereas, in the older age group, neither the maxillary nor the mandibular teeth were affected by this form. Dentine and enamel caries were more common in the lower dentition of all ages, whereas the opposite was the case for fillings (Figs. 5.27a and 5.27b).

Occlusal caries

Of all occlusal surfaces examined, 39.5% (70 / 177) showed evidence of occlusal caries. Molars (52.8%, 50.0% and 43.2% for first, second and third molars, respectively) were markedly more frequently affected than premolars (11.8% and 34.6% for first and second premolars, respectively). The teeth most affected were first molars (52.8%) and the teeth least affected were first premolars (11.8%). The rates of occlusal surface caries were slightly higher in the lower (40.6%) than the upper (38.2%) teeth, and increased from 39.6% in young adults to 40.3% in middle adults and again decreased to 33.3% in older individuals.

Pit caries

The frequency of pit caries (39.9% - 55 / 138) was slightly higher than that of occlusal surface caries. The percentages were markedly higher for molars (50.0%, 48.8% and 36.8% for first, second and third molars, respectively) than incisors (0.0% and 15.4% for first and second incisors). First molars were the most affected tooth type and first incisors the least affected. The rates were higher in the lower (53.8%) than the upper (27.4%) teeth and steadily decreased from 43.8% in young to 40.7% in middle and 9.1 in older individuals.

Occlusal attrition facet caries

Of all occlusal attrition facets examined, 21.0% (58 / 276) showed evidence of occlusal attrition facet dentine caries. Third molars were the most frequently affected tooth type (60.0%) and second incisors the least (0.0%). Posterior teeth were more frequently attacked by caries in the attrition facet than anterior teeth. The frequencies of caries were higher in the upper (23.0%) than the lower (19.5%) dentition and markedly increased with age, from 17.8% in young adults to 23.9% in the middle and 29.4% in the older individuals.

Contact caries

Of all contact areas between neighbouring teeth (mesial and distal) examined, 21.6% (119 / 550) showed evidence of contact caries. Second premolars were the most frequently affected tooth type (37.0%) and first incisors the least (3.7%). In general, posterior teeth were most frequently attacked by contact caries than anterior teeth. The percentages were slightly higher in the upper (24.8%) than the lower (19.2%) dentition and decreased from 23.3% in the young to 18.8% in the middle adults, but rose to 26.5% in older individuals.

Smooth surface caries

Of all smooth surfaces (buccal and lingual) examined, 12.2% (68 / 558) showed evidence of smooth surface caries. First molars were the most frequently affected tooth type (19.4%) and first incisors the least (7.4%). Posterior teeth were more frequently affected than anterior. The percentages were higher for the upper (14.0%) than the lower (10.8%) dentition and decreased from 12.8% in young adults to 10.6% in the middle but rose to 17.6% in older individuals.

Root surface caries

Of all root surfaces (mesial, distal, buccal and lingual) examined, 10.9% (121 / 1108) showed evidence of root surface caries. Second premolars were the most frequently affected tooth type (21.3%) and first incisors the least (5.6%). Posterior teeth were more frequently affected than anterior. The percentages were higher in the lower (11.9%) than the upper (9.6%) dentition and increased in the first two age classes, from 10.1% in young to 12.7% in middle adults, but decreased to 5.9% in the oldest group.

5.1.3.2.2 High SES

Teeth examined and missing

The total number of observable tooth sockets for high SES in Athens was 944, of which, 507 (53.7%) teeth were lost antemortem, 235 (24.9%) were lost postmortem. Eruption problems were observed in 12 (1.3%) teeth. Overall, 189 (20.0% of observable tooth sockets) were examined for the presence of carious lesions. The frequency rates of teeth present, lost antemortem and postmortem, and of those with eruption problems, regardless of age, are presented in Table 5.6b, and by age group, in Figures 5.28a and 5.28b for upper and lower dentition, respectively. The most frequently missing tooth class were first molars, and first molars of older adults (87.5%) in particular, whereas first incisors were the least frequently missing, with none of first incisors of young adults lost antemortem. AMTL was generally more common in posterior teeth. First incisors were the most frequently missing (PMTL) tooth type (100.0%, 63.2% and 30.6%, for young, middle and older individuals, respectively) and third molars the least (50.0%, 7.9% and 0.0%, for young, middle and older individuals, respectively). The frequency of teeth present was equal for upper and lower teeth in young adults but higher in lower teeth of middle and older individuals (Figs. 5.28a &

Tooth Type		Present	Lost AM	Lost PM	Unobser vable	Eruption Problems	Total
1	**N**	17	47	54	0	0	**118**
	%	14.4%	39.8%	45.8%	.0%	.0%	**100.0%**
2	**N**	21	49	48	0	0	**118**
	%	17.8%	41.5%	40.7%	.0%	.0%	**100.0%**
3	**N**	31	48	38	1	0	**118**
	%	26.3%	40.7%	32.2%	.8%	.0%	**100.0%**
4	**N**	23	61	34	0	0	**118**
	%	19.5%	51.7%	28.8%	.0%	.0%	**100.0%**
5	**N**	19	70	29	0	0	**118**
	%	16.1%	59.3%	24.6%	.0%	.0%	**100.0%**
6	**N**	23	84	11	0	0	**118**
	%	19.5%	71.2%	9.3%	.0%	.0%	**100.0%**
7	**N**	34	70	14	0	0	**118**
	%	28.8%	59.3%	11.9%	.0%	.0%	**100.0%**
8	**N**	21	78	7	0	12	**118**
	%	17.8%	66.1%	5.9%	.0%	10.2%	**100.0%**
Total	**N**	**189**	**507**	**235**	**1**	**12**	**944**
	%	**20.0%**	**53.7%**	**24.9%**	**.1%**	**1.3%**	**100.0%**

Table 5.6b: Number and percentages of teeth present, missing antemortem, lost postmortem, and with eruption related problems in each tooth type (upper and lower together), regardless of age, in the high SES group from Athens.

5.28b). Maxillary teeth suffered AMTL more frequently than mandibular teeth in all age classes. Upper teeth of middle and older adults were lost postmortem more often than lower, whereas the opposite was the case for young adults(Figs. 5.28a & 5.28b). Eruption problems were much more common in the upper teeth of middle individuals and in the lower teeth of older individuals; no eruption problem were observed in the teeth of young adults(Figs. 5.28a & 5.28b).

<u>Caries</u>

In the high SES population from Demetrias, 47.6% (91 / 191) of the permanent teeth and 100.0% (18 / 18) of individuals with surviving teeth were affected by caries. When only cavitated lesions were considered, the first figure decreased to

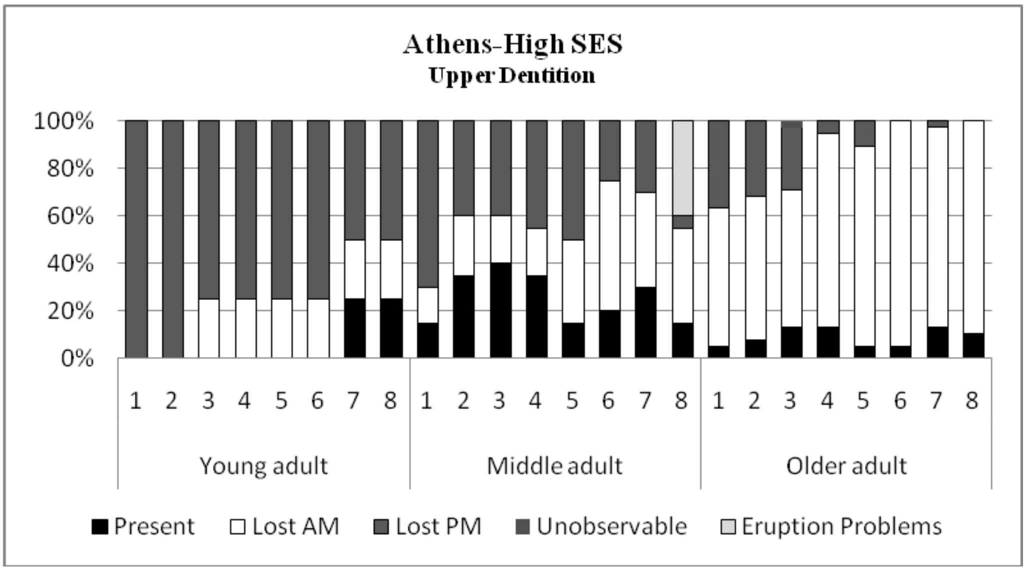

Figure 5.28a: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (upper dentition), by age group, in the high SES group from Athens.

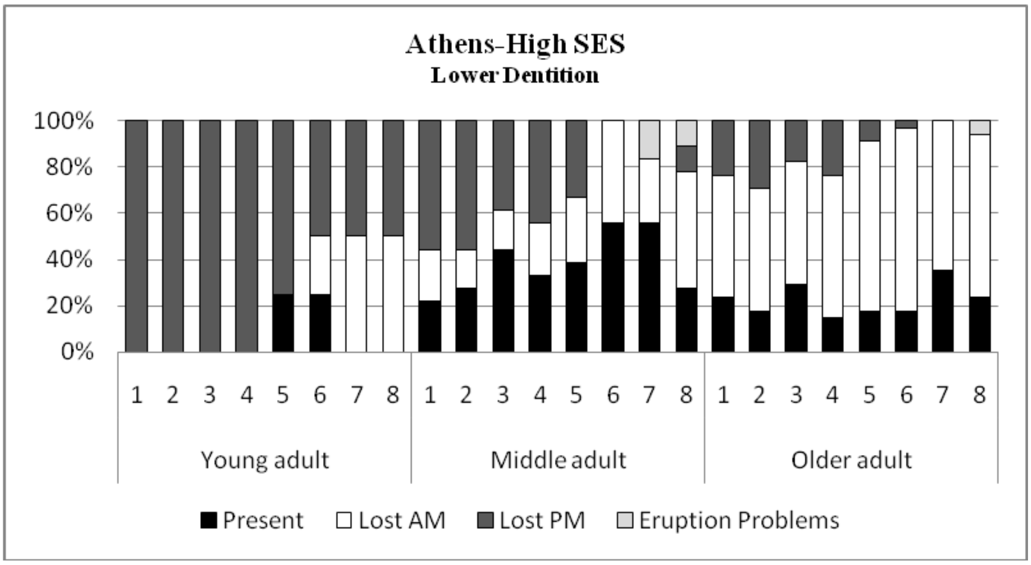

Figure 5.28b: Frequency rates of teeth present, missing antemortem, lost postmortem, unobservable, and with eruption related problems for each tooth type (lower dentition), by age group, in the high SES group from Athens.

42.4% (81 / 191), whereas the second remained the same (100%, 18 / 18). Of 18 high SES individuals with dentitions, only 2 (11.1%) had only one decayed tooth. Gross cavities, in at least one tooth, were observed in 33.3% (6 / 18) of high SES individuals. It should be noted that all the above figures, except the last one (gross cavities), include fillings.

In Figures 5.29a, 5.29b and 5.29c, AMTL and caries rates, on any tooth surface and regardless of lesion type, are presented for each tooth type by age group. In the younger age group, 75.0% of all teeth were carious. This decreased to 43.9% in middle adults and again increased to 50.6% in the older individuals. The rates of AMTL were 17.2% in the young, 29.9% in the middle and 70.3% in the older individuals. Posterior teeth were affected by both caries and AMTL more often than anterior teeth. Carious lesions, as well as AMTL, attacked upper more frequently than lower dentitions. The most frequently involved teeth (upper and lower together) were first molars for both caries (78.3%) and AMTL (71.2%).

In Figures 5.30a and 5.30b, caries frequency rates are presented for each tooth type by age group in low SES individuals, according to the severest lesion type on any surface of the tooth. Dentine lesions were the only form, except for fillings, observed in young adults. In the middle adult age group, enamel lesions were the most common form of caries, followed by dentine and pulp lesions (Figs. 5.30a & 5.30b). In the oldest age group, pulp lesions were the most frequently observed form, followed by dentine and enamel lesions(Figs. 5.30a & 5.30b). Fillings' rates were very high and more common than any other type of lesion in all age groups; this difference however, was very pronounced in young and middle individuals(Figs. 5.30a & 5.30b).

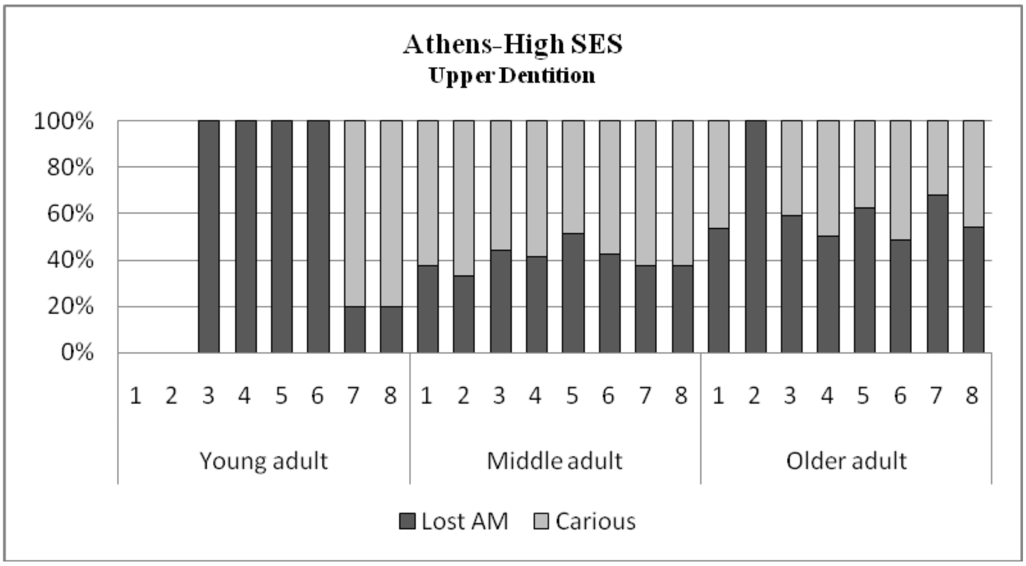

Figure 5.29a: Caries and antemortem tooth loss frequency rates for each tooth type (upper dentition), by age group, in the high SES group from Athens.

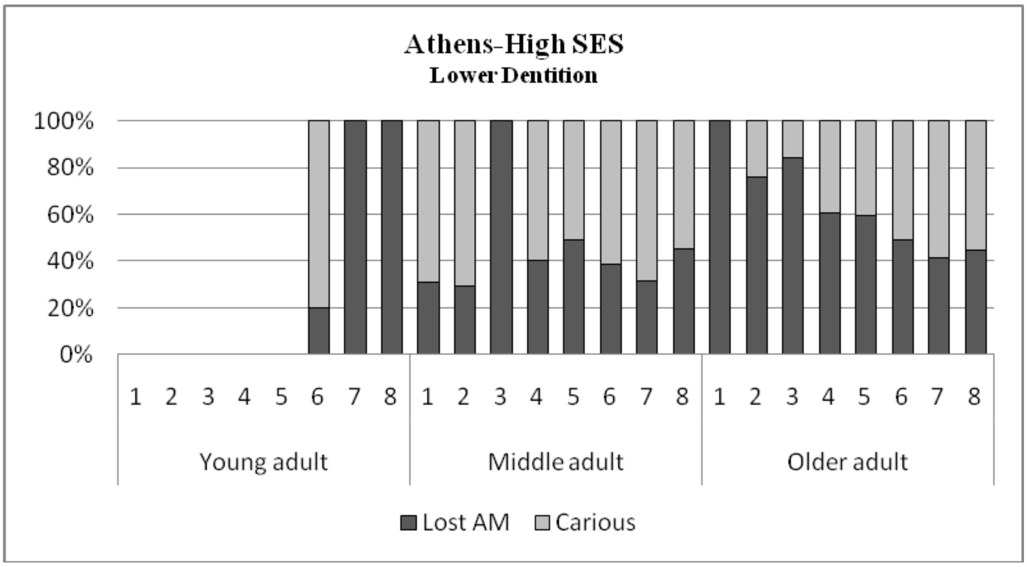

Figure 5.29b: Caries and antemortem tooth loss frequency rates for each tooth type (lower dentition), by age group, in the high SES group from Athens.

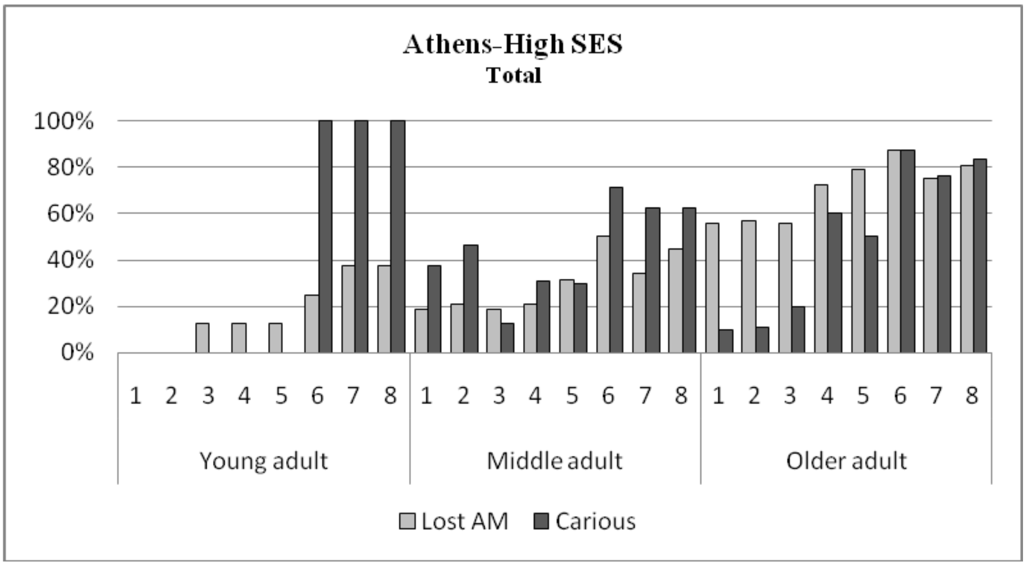

Figure 5.29c: Caries and antemortem tooth loss frequency rates for each tooth type (upper and lower dentition together), by age group, in the high SES group from Athens.

Enamel lesions were rare in the first two age groups with middle adults being the most frequently affected age group; lesions of this form were not observed in older adults. Pulp exposing lesion rates steadily increased with age. Dentine lesion rates greatly decreased from the youngest to the middle adult age group but again slightly rose in the older age class. Fillings rates steadily decreased as age progressed (Figs. 5.30a & 5.30b). Overall, pulp and dentine lesions, as well as fillings predominated in the posterior teeth, whereas lesions confined to the enamel were more common in anterior teeth. When upper and lower dentitions were compared, fillings rates were higher in the former, whereas pulp, dentine and enamel lesions were more common in mandibular teeth ((Figs. 5.30a & 5.30b).

Similar were the patterns observed separately in each age group. Lesions penetrating to the pulp chamber were predominant in the posterior teeth of middle and older individuals; young adults were not affected by this form.

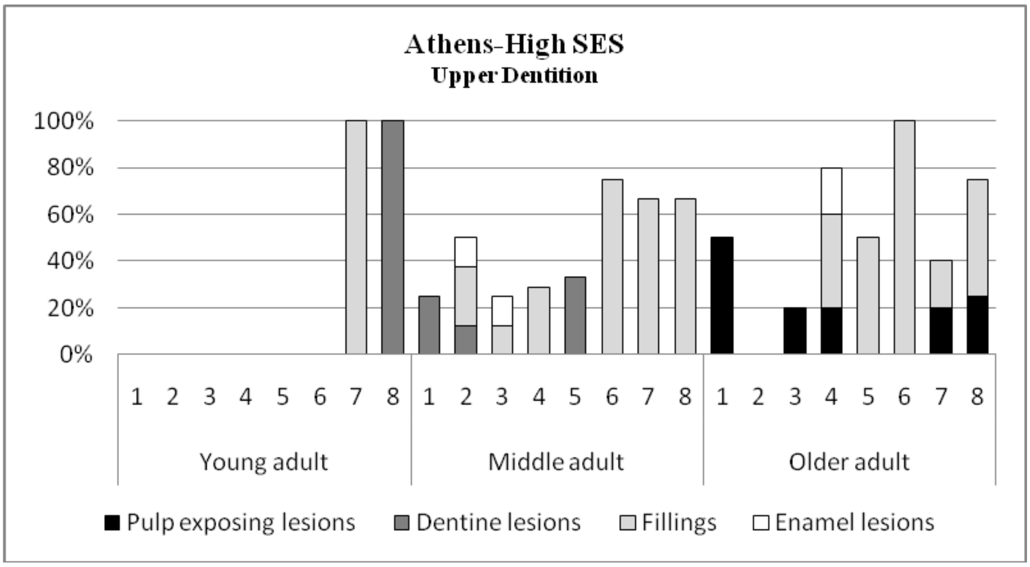

Figure 5.30a: Caries frequency rates for each tooth type (upper dentition), by age group, according to the severest lesion type on any surface of the tooth, in the high SES group from Athens.

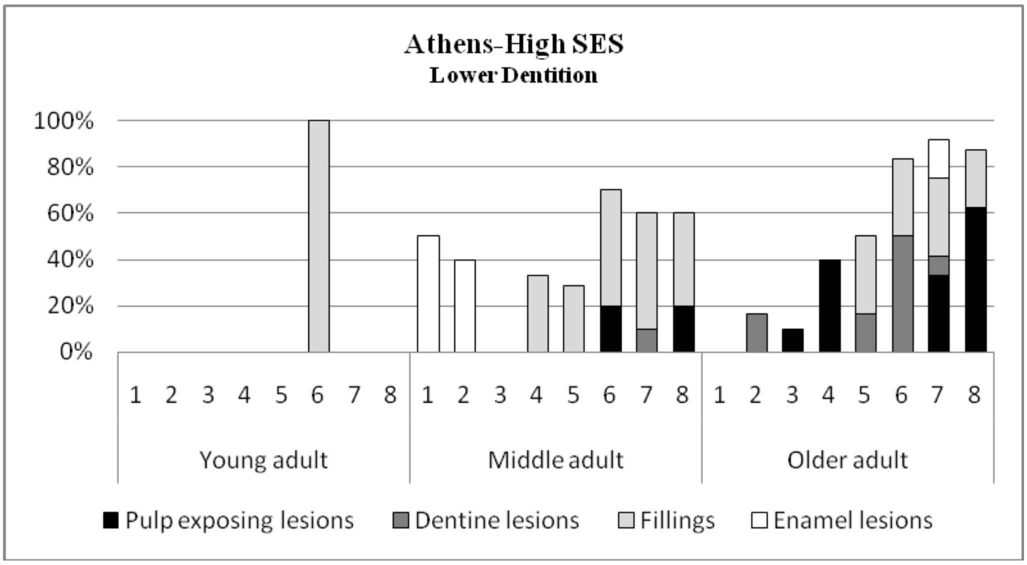

Figure 5.30b: Caries frequency rates for each tooth type (lower dentition), by age group, according to the severest lesion type on any surface of the tooth, in the high SES group from Athens.

Dentine lesions were more frequent in the anterior teeth of young and older individuals and the anterior teeth of middle adults(Figs. 5.30a & 5.30b). Fillings' rates were higher in the posterior teeth in all age classes. Pulp lesions more frequently affected the lower dentition of middle and older individuals; neither the maxillary nor the mandibular teeth the youngest age group were affected by this form (Figs. 5.30a & 5.30b). Dentine lesions were more common in the upper dentition of young and middle individuals and the lower dentition of the older adults. Fillings' rates were higher in the maxillary teeth of all age classes. Enamel caries more often affected the lower dentition of middle adults and the upper dentition of older adults; neither the maxillary nor the mandibular teeth of young individuals were affected by this form (Figs. 5.30a & 5.30b).

Occlusal caries

Of all occlusal surfaces examined, 56.1% (60 / 107) showed evidence of occlusal caries. Molars (85.0%, 59.4% and 60.0% for first, second and third molars, respectively) were markedly more frequently affected than premolars (35.0% and 33.3% for first and second premolars, respectively). The teeth most affected were first molars (85.0%) and the teeth least affected were second premolars (33.3%). The rates of occlusal surface caries were higher in the lower (60.6%) than the upper (48.8%) teeth, and decreased from 75.0% in young adults to 54.0% in middle adults and again rose to 56.6% in older individuals.

Pit caries

The frequency of pit caries (55.1% - 49 / 89) was higher than that of occlusal surface caries. The percentages were markedly higher for molars (66.7%, 59.4% and 61.9% for first, second and third molars, respectively) than incisors (20.0%

and 20.0% for first and second incisors). First molars were the most affected tooth type and first and second incisors the least affected. The rates were higher in the lower (62.5%) than the upper (46.3%) teeth and decreased through the first two age groups from 100.0% in young to 52.3% in middle adults but again slightly increased to 54.8% in older individuals.

Occlusal attrition facet caries

Of all occlusal attrition facets examined, 28.7% (54 / 188) showed evidence of occlusal attrition facet dentine caries. Third molars were the most frequently affected tooth type (60.0%) and second incisors the least (0.0%). Posterior teeth were more frequently attacked by caries in the attrition facet than anterior teeth. The frequencies of caries were higher in the upper (29.6%) than the lower (28.2%) dentition and markedly decreased in the first two age groups, from 33.3% in young adults to 25.0% in the middle adults, and again rose to 32.6% in the older individuals.

Contact caries

Of all contact areas between neighbouring teeth (mesial and distal) examined, 30.0% (113 / 377) showed evidence of contact caries. First molars were the most frequently affected tooth type (52.2%) and first incisors the least (8.8%). In general, posterior teeth were most frequently attacked by contact caries than anterior teeth. The percentages were slightly higher in the upper (31.7%) than the lower (28.9%) dentition, and remained the same in the first two age groups (25.0%) but increased to 35.6% in the older individuals.

<u>Smooth surface caries</u>

Of all smooth surfaces (buccal and lingual) examined, 18.8% (71 / 377) showed evidence of smooth surface caries. Second molars were the most frequently affected tooth type (38.2%) and second incisors the least (0.0%). Posterior teeth were more frequently affected than anterior. The percentages were higher for the lower (19.1%) than the upper (18.3%) dentition and decreased from 25.0% in young adults to 13.5% in the middle but rose again to 24.3% in older individuals.

<u>Root surface caries</u>

Of all root surfaces (mesial, distal, buccal and lingual) examined, 12.1% (91 / 755) showed evidence of root surface caries. Second molars were the most frequently affected tooth type (25.2%) and second premolars the least (0.0%). Posterior teeth were more frequently affected than anterior. The percentages were higher in the upper (13.0%) than the lower (11.5%) dentition and decreased in the first two age groups, from 100.0% (very small sample) in young to 9.6% in middle adults, but again rose to 15.2% in the oldest group.

5.2 Occlusal Wear

As has already been mentioned in the *Methodology* (4.7.3), in order to facilitate the presentation of the results, the stages in Smith's (1984) method were reduced to three groups. Thus, both overall and by age group frequencies of slight, moderate and heavy wear are presented first. Comparisons between tooth types, upper and lower dentition and anterior and posterior teeth are also included. Finally, this section reports percentages for each one of the eight stages in Smith's (1984) system and how these increased or decreased among the age groups. Related information are provided in the *Methodology* (*Chapter 4*) in 4.7.2. and 4.7.3.

5.2.1. Within populations

5.2.1.1 Demetrias

A total number of 3395 permanent teeth and 238 individuals were scored for occlusal attrition. All teeth (100.0%) and 238 individuals (100.0%) displayed signs of occlusal attrition, which ranged from slight wear of small areas of the enamel surface (stage 1 in Smith's (1984) method) to severe loss of crown height (stage 8 in Smith's (1984) method). Overall, 500 (14.7%) teeth showed slight wear (stages 1 and 2), 1344 (39.6%) teeth showed moderate wear (stages 3 and 4), and 1551 (45.7%) teeth showed heavy wear (stages 5 to 8). Slight and moderate wear decreased with age, whereas heavy wear increased with age. More specifically, the overall (regardless of tooth type) wear frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were the following: (a) 29.1%, 8.8% and 5.5% for slight wear, (b) 49.3%, 37.0% and 28.7% for moderate wear, and (c) 21.6%, 54.2%, and 65.8% for heavy wear, respectively.

The teeth in the ancient population, generally, present a high frequency of heavy wear (Fig. 5.31). Analysis by tooth type, regardless of upper and lower dentition, first molars showed heavy wear in 74.5% and were the most heavily worn teeth. The second most frequently affected (by heavy wear) tooth type was second molars (53.6%), followed by first incisors (47.0%) and second premolars (45.4%). Third molars (28.2%) and canines (32.9%) displayed the lowest frequencies of heavy wear. The lower teeth (12.1%, 42.2% and 45.7% for slight, moderate and heavy wear, respectively) were more worn than the upper ones (18.3%, 36.0%

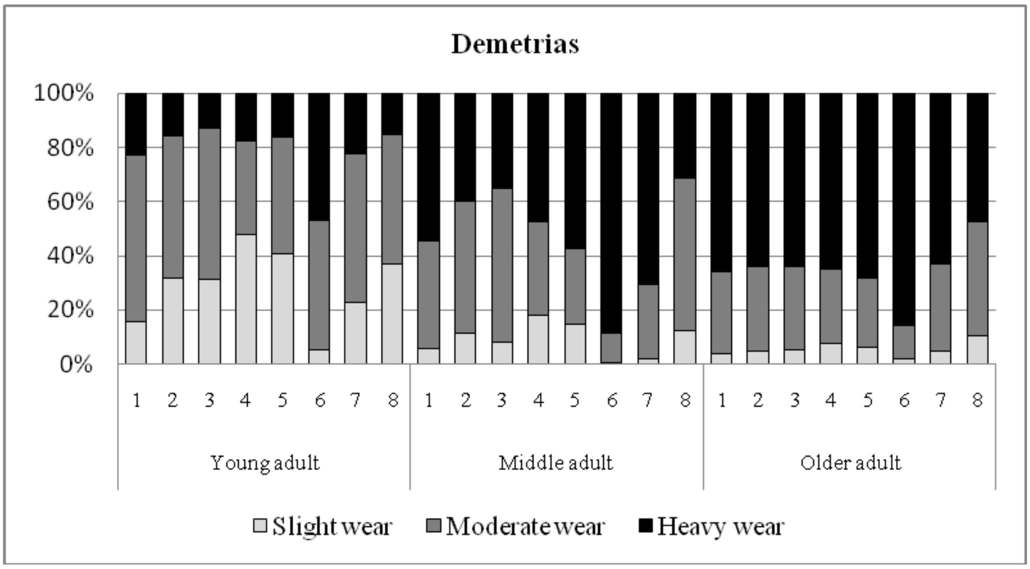

Figure 5.31: Frequency rates of teeth with slight, moderate and heavy wear for each tooth type (upper and lower dentition together), by age group, in Demetrias.

and 45.6% for slight, moderate and heavy wear, respectively), and the posterior teeth were more worn than the anterior ones. When upper and lower dentition were considered separately, the most heavily worn teeth were the lower first molars, with 74.6% of them affected by heavy wear, whereas the least affected were the upper third molars (19.3%). Comparisons between upper and lower dentition by tooth type revealed big differences in some of them, such as that observed in third molars (19.3% and 33.9% for upper and lower, respectively), but very small differences, such as that in first molars (74.4% and 74.6% for upper and lower, respectively) as well. Heavy wear increased with age on all tooth types, apart from the first and the second molars, on which it increased from young to middle adults but decreased in the older age group; thus the middle age class had the maximum wear on first and second molars (Fig. 5.31).

When the eight stages in Smith's (1984) method were considered separately, the highest percentage of teeth was affected by stages 4 and 5 and the lowest percentage by stages 1 and 8. More specifically, the frequencies were the following: 1: 0.9%, 2: 13.8%, 3: 17.6%, 4: 21.9%, 5: 20.2%, 6: 14.8%, 7: 9.0%, and 8: 1.6%. When comparisons among the three age groups were made, an interesting pattern emerged; frequencies steadily increased with age in slight and moderate wear stages 2, 3 and 4 but steadily decreased with age in heavy wear stages 6, 7 and 8, whereas the middle age class had the highest percentage of slight wear stage 1 and heavy wear stage 5.

5.2.1.2 Athens

A total number of 934 permanent teeth and 124 individuals were scored for occlusal attrition. All teeth (100.0%) and 124 individuals (100.0%) displayed signs of occlusal attrition, which ranged from slight wear of small areas of the enamel surface (stage 1 in Smith's (1984) method) to severe loss of crown height (stage 8 in Smith's (1984) method). Overall, 600 (65.2%) teeth showed slight wear (stages 1 and 2), 291 (31.2%) teeth showed moderate wear (stages 3 and 4), and 34 (3.6%) teeth showed heavy wear (stages 5 to 8). Slight wear decreased with age, whereas moderate and heavy wear increased with age. More specifically, the overall (regardless of tooth type) wear frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were the following: (a) 79.2%, 67.5% and 34.0% for slight wear, (b) 19.4%, 30.2% and 55.3% for moderate wear, and (c) 1.4%, 2.3%, and 10.6% for heavy wear, respectively.

In general the teeth in the modern population present a low frequency of heavy wear (Fig. 5.32). Analysis by tooth type, regardless of upper and lower dentition, revealed that first incisors had heavy wear in 7.8% and were the most heavily worn teeth. The second most frequently affected (by heavy wear) tooth type was second incisors (5.6%), followed by first molars (4.7%) and canines (4.4%).

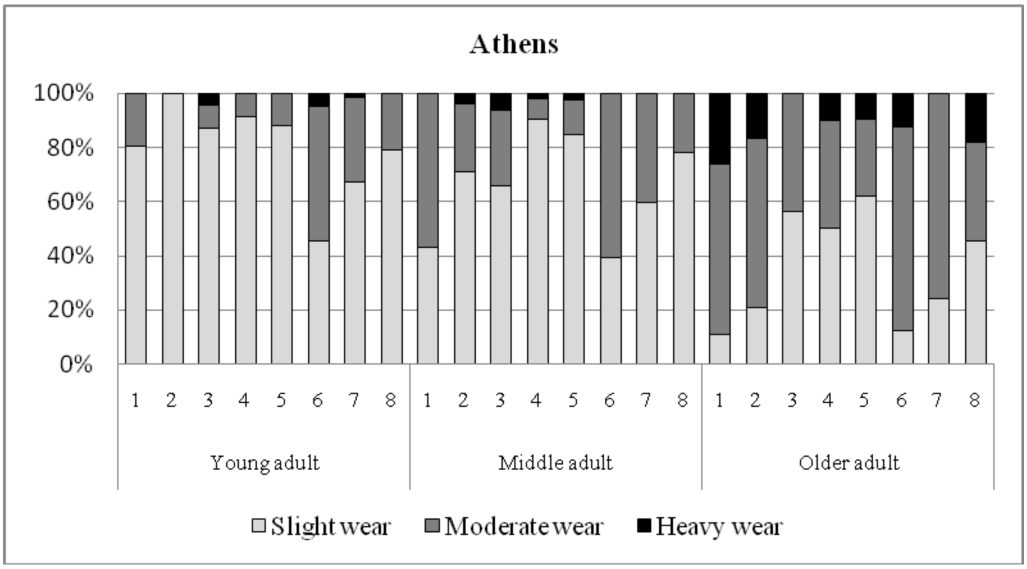

Figure 5.32: Frequency rates of teeth with slight, moderate and heavy wear for each tooth type (upper and lower dentition together), by age group, in Athens.

Second and third molars (0.7% and 2.1%, respectively) displayed the lowest frequencies of heavy wear. The upper teeth displayed slightly higher frequencies of heavy wear but lower frequencies of moderate wear (68.3%, 27.8% and 3.9% for slight, moderate and heavy wear, respectively) than the lower ones (62.8%, 33.8% and 3.4% for slight, moderate and heavy wear, respectively), and the anterior teeth were more worn than the posterior ones. When upper and lower dentition were considered separately, the most heavily worn teeth were the upper second incisors, with 10.9% of them affected by heavy wear, whereas the least affected were the lower first premolars (1.3%). Comparisons between upper and lower dentition by tooth type revealed big differences in some of them, such as that observed in second incisors (10.9% and 1.6% for upper and lower, respectively), but very small differences, such as that in canines (4.3% and 4.5% for upper and lower, respectively) as well. It should be noted, however, that these results should be treated with caution given that, when subdividing the assemblage into upper and lower teeth, the subsample sizes became small. Heavy wear steadily increased with age on all tooth types (Fig. 5.32).

When the eight stages in Smith's (1984) method were considered separately, the highest percentage of teeth was affected by stages 2 and 3 and the lowest percentage by stages 5, 6, 7 and 8. More specifically, the frequencies were the following: 1: 11.3%, 2: 53.9%, 3: 21.8%, 4: 9.3%, 5: 2.0%, 6: 1.1%, 7: 0.4%, and 8: 0.1%. When comparisons among the three age groups were made, it was revealed that frequencies steadily increased with age in moderate and heavy wear stages 3, 4, 5, 6 and 7, but steadily decreased with age only in slight wear stage 1, whereas the middle age class had the highest percentage of slight wear stage 2 and heavy wear stage 8.

5.2.2 Within sexes

5.2.2.1 Demetrias

5.2.2.1.1 Females

A total number of 1399 female permanent teeth and 103 individuals were scored for occlusal attrition in Demetrias. All teeth (100.0%) and 103 individuals (100.0%) displayed signs of occlusal attrition, which ranged from slight wear of small areas of the enamel surface (stage 1 in Smith's (1984) method) to severe loss of crown height (stage 8 in Smith's (1984) method). Overall, 325 (23.2%) teeth showed slight wear (stages 1 and 2), 578 (41.3%) teeth showed moderate wear (stages 3 and 4), and 496 (35.5%) teeth showed heavy wear (stages 5 to 8). Slight and moderate wear decreased with age, whereas heavy wear increased from young to middle but slightly decreased in the older age group. More specifically, the overall (regardless of tooth type) wear frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were the following: (a) 34.9%, 15.1% and 18.3% for slight wear, (b) 42.6%, 41.0% and 40.5% for moderate wear, and (c) 22.5%, 43.9%, and 41.2% for heavy wear, respectively.

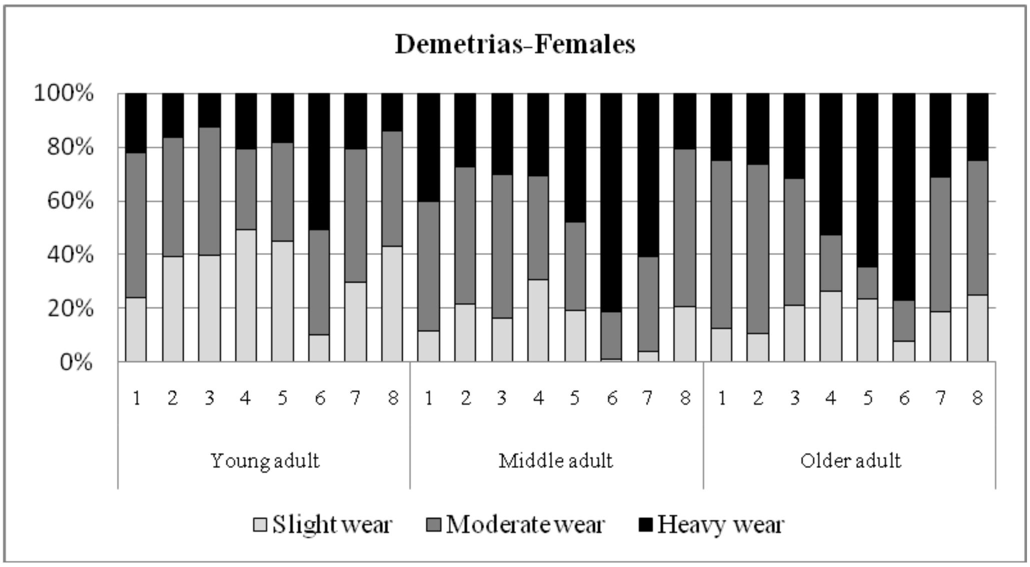

Figure 5.33: Frequency rates of teeth with slight, moderate and heavy wear for each tooth type (upper and lower dentition together), by age group, in females from Demetrias.

In general, the teeth in the female population of Demetrias present a high frequency of heavy wear (Fig. 5.33). Analysis by tooth type, regardless of upper and lower dentition, revealed that first molars had heavy wear in 68.5% and were the most heavily worn teeth. The second most frequently affected (by heavy wear) tooth type was second molars (42.8%), followed by second premolars (37.6%) and first incisors (31.4%). Third molars and second incisors (18.2% and 23.2%, respectively) displayed the lowest frequencies of heavy wear. Mandibular teeth displayed higher frequencies of both heavy and moderate wear (19.7%, 44.5% and 35.8% for slight, moderate and heavy wear, respectively) than the maxillary ones (28.1%, 36.9% and 35.0% for slight, moderate and heavy wear, respectively), and the posterior teeth were more worn than the anterior ones. When maxillary and mandibular dentitions were considered separately, the most heavily worn teeth were the lower first molars, with 71.3% of them affected by heavy wear, whereas the least affected were the upper third molars (12.0%).

When percentages for each of the eight stages in Smith's (1984) method were estimated separately, the highest percentage of teeth was affected by stages 2, 3 and 4 and the lowest percentage by stages 1, 7 and 8. More specifically, the frequencies were the following: 1: 1.7%, 2: 21.5%, 3: 20.7%, 4: 20.7%, 5: 17.4%, 6: 11.9%, 7: 6.1%, and 8: 0.1%. When comparisons among the three age groups were made, it was revealed that frequencies steadily decreased with age in moderate wear stage 3 and heavy wear stage 8, steadily increased with age in moderate wear stage 4 and heavy wear stage 5. The middle age class had the highest percentage of heavy wear stages 6 and 7, whereas slight wear stages 1 and 2 decreased from the young to the middle age group and again increased in the older age group.

5.2.2.1.2 Males

A total number of 1996 male permanent teeth and 135 individuals were scored for occlusal attrition in Demetrias. All teeth (100.0%) and 135 individuals (100.0%) displayed signs of occlusal attrition, which ranged from slight wear of small areas of the enamel surface (stage 1 in Smith's (1984) method) to severe loss of crown height (stage 8 in Smith's (1984) method). Overall, 175 (8.8%) teeth showed slight wear (stages 1 and 2), 766 (38.4%) teeth showed moderate wear (stages 3 and 4), and 1055 (52.9%) teeth showed heavy wear (stages 5 to 8). Slight and moderate wear decreased with age, whereas heavy wear increased with age. More specifically, the overall (regardless of tooth type) wear frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were the following: (a) 22.8%, 4.9% and 0.6% for slight wear, (b) 56.5%, 34.5% and 24.2% for moderate wear, and (c) 20.7%, 60.6%, and 75.2% for heavy wear, respectively.

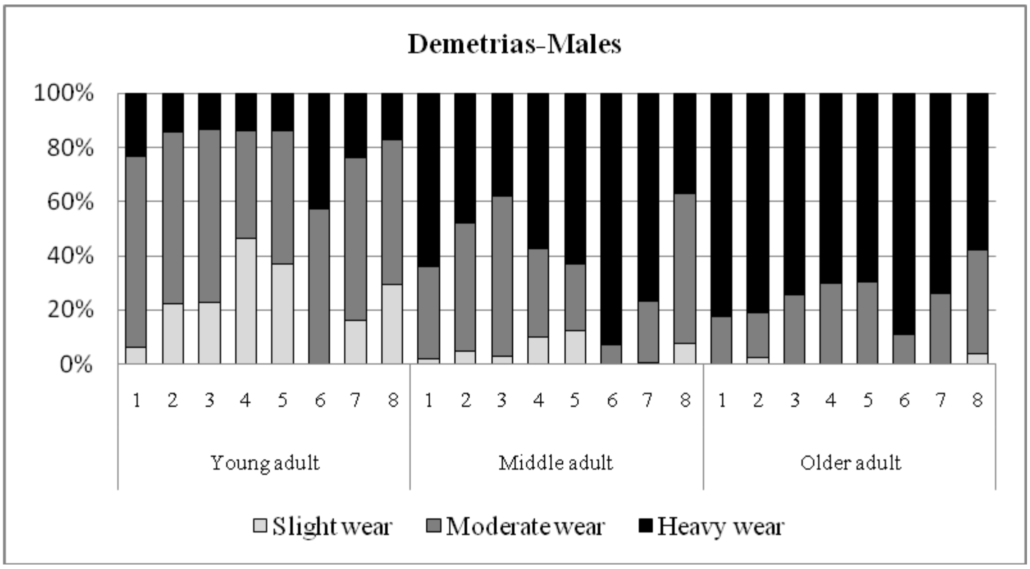

Figure 5.34: Frequency rates of teeth with slight, moderate and heavy wear for each tooth type (upper and lower dentition together), by age group, in males from Demetrias.

In general, the teeth in the male population of Demetrias present a high frequency of heavy wear (Fig. 5.34). Analysis by tooth type, regardless of upper and lower dentition, revealed that first molars had heavy wear in 78.8% and were the most heavily worn teeth. The second most frequently affected (by heavy wear) tooth type was second molars (61.2%), followed by first incisors (58.1%) and second premolars (50.6%). Third molars and canines (35.3% and 39.1%, respectively) displayed the lowest frequencies of heavy wear. Mandibular teeth displayed higher frequencies of moderate wear but slightly lower frequencies of slight and heavy wear (6.8%, 40.5% and 52.7% for slight, moderate and heavy wear, respectively) than the maxillary ones (11.5%, 35.4% and 53.0% for slight, moderate and heavy wear, respectively), and the posterior teeth were more worn than the anterior ones. When maxillary and mandibular dentitions were considered separately, the most heavily worn teeth were the upper first molars, with 81.4% of them affected by heavy wear, whereas the least affected were the upper third molars (25.0%).

When percentages for each of the eight stages in Smith's (1984) method were estimated separately, the highest percentage of teeth was affected by stages 4 and 5 and the lowest percentage by stages 1 and 8. More specifically, the frequencies were the following: 1: 0.4%, 2: 8.4%, 3: 15.5%, 4: 22.8%, 5: 22.1%, 6: 16.9%, 7: 11.1%, and 8: 2.8%. When comparisons among the three age groups were made, it was revealed that frequencies steadily decreased with age in slight wear stages 1 and 2 and moderate wear stages 3 and 4, and steadily increased with age in heavy wear stages 6, 7 and 8; heavy wear stage 5 rates increased from the first to the second age group but decreased in the third one.

5.2.2.2 Athens

5.2.2.2.1 Females

A total number of 397 female permanent teeth and 58 individuals were scored for occlusal attrition in Athens. All teeth (100.0%) and 58 individuals (100.0%) displayed signs of occlusal attrition, which ranged from slight wear of small areas of the enamel surface (stage 1 in Smith's (1984) method) to severe loss of crown height (stage 8 in Smith's (1984) method). Overall, 273 (68.8%) teeth showed slight wear (stages 1 and 2), 116 (29.2%) teeth showed moderate wear (stages 3 and 4), and 8 (2.0%) teeth showed heavy wear (stages 5 to 8). Slight wear decreased through the three age groups, whereas moderate and heavy wear steadily increased with age. More specifically, the overall (regardless of tooth type) wear frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were the following: (a) 88.5%, 68.8% and 44.4% for slight wear, (b) 11.5%, 30.1% and 49.5% for moderate wear, and (c) 0.0%, 1.1%, and 6.1% for heavy wear, respectively.

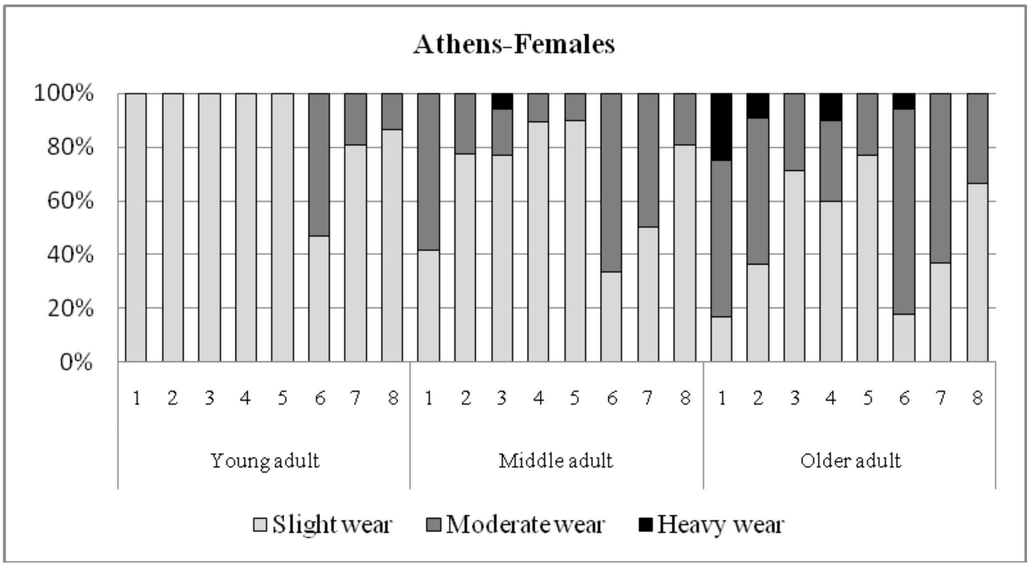

Figure 5.35: Frequency rates of teeth with slight, moderate and heavy wear for each tooth type (upper and lower dentition together), by age group, in females from Athens.

In general, the teeth in the female population of Athens present a low frequency of heavy wear (Fig. 5.35). Analysis by tooth type, regardless of upper and lower dentition, revealed that first incisors had heavy wear in 8.6% and were the most heavily worn teeth. Second premolars were the least worn tooth type, with none of them (0.0%) displaying heavy wear and 11.4% of them showing moderate wear. Mandibular teeth displayed higher frequencies of both heavy and moderate wear (67.1%, 29.6% and 3.2% for slight, moderate and heavy wear, respectively) than the maxillary ones (70.7%, 28.7% and 0.6% for slight, moderate and heavy wear, respectively), and the anterior teeth were more worn than the posterior ones. When maxillary and mandibular dentitions were considered separately, the most heavily worn teeth were the lower canines, with 5.1% of them affected by heavy wear, whereas the least affected were the upper second premolars (100.0% slight wear).

When percentages for each of the eight stages in Smith's (1984) method were estimated separately, the highest percentage of teeth was affected by stage 2 and the lowest percentage by stages 5, 6, 7 and 8. More specifically, the frequencies were the following: 1: 9.3%, 2: 59.4%, 3: 20.7%, 4: 8.6%, 5: 1.3%, 6: 0.0%, 7: 0.5%, and 8: 0.3%. When comparisons among the three age groups were made, it was revealed that frequencies steadily decreased with age in slight wear stage 1 and steadily increased with age in moderate wear stage 4 and heavy wear stages 5 and 7. Percentages of wear stages 2, 3 and 8 increased from the first to the second age group but decreased in the third. Rates for stage 6 were 0.0% in all age classes.

5.2.2.2.2 Males

A total number of 537 male permanent teeth and 66 individuals were scored for occlusal attrition in Athens. All teeth (100.0%) and 66 individuals (100.0%) displayed signs of occlusal attrition, which ranged from slight wear of small areas of the enamel surface (stage 1 in Smith's (1984) method) to severe loss of crown height (stage 8 in Smith's (1984) method). Overall, 336 (62.6%) teeth showed slight wear (stages 1 and 2), 175 (32.6%) teeth showed moderate wear (stages 3 and 4), and 26 (4.8%) teeth showed heavy wear (stages 5 to 8). Slight wear decreased through the three age groups, whereas moderate and heavy wear steadily increased with age. More specifically, the overall (regardless of tooth type) wear frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were the following: (a) 74.2%, 66.5% and 22.5% for slight wear, (b) 23.6%, 30.2% and 61.8% for moderate wear, and (c) 2.1%, 3.3%, and 15.7% for heavy wear, respectively.

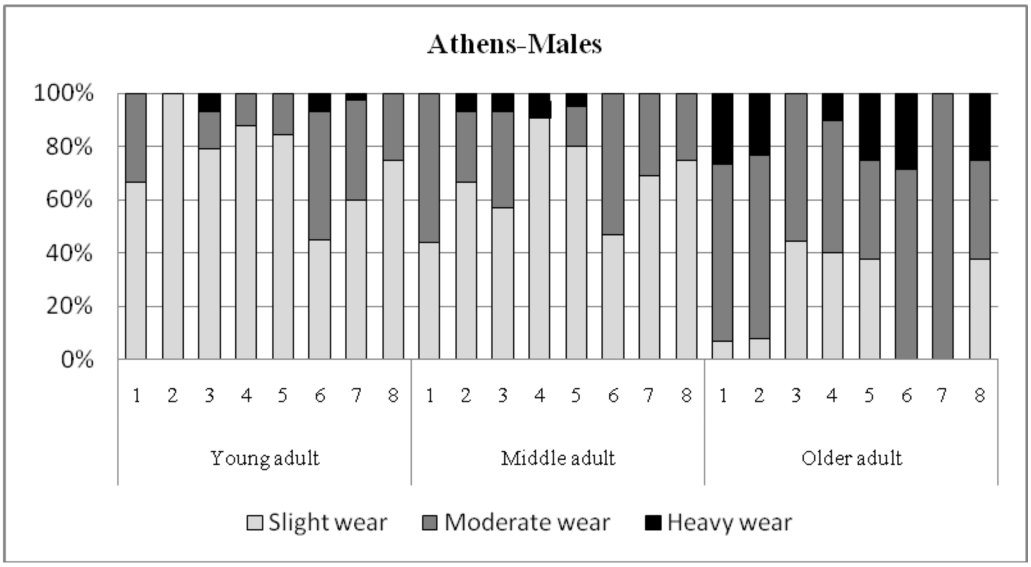

Figure 5.36: Frequency rates of teeth with slight, moderate and heavy wear for each tooth type (upper and lower dentition together), by age group, in males from Athens.

In general, the teeth in the male population of Athens present a low frequency of heavy wear (Fig. 5.36). Analysis by tooth type, regardless of upper and lower dentition, revealed that second incisors had heavy wear in 8.1% and were the most heavily worn teeth. Second molars were the least worn tooth type, with 1.3% of them displaying heavy wear. Mandibular teeth displayed higher frequencies of moderate wear but lower frequencies of slight and heavy wear (59.8%, 36.7% and 3.5% for slight, moderate and heavy wear, respectively) than the maxillary ones (66.4%, 27.0% and 6.6% for slight, moderate and heavy wear, respectively), and the anterior teeth were more worn than the posterior ones. When maxillary and mandibular dentitions were considered separately, the most heavily worn teeth were the upper second incisors, with 20.0% of them affected by heavy wear, whereas the least affected were the lower first premolars (87.8% slight and 12.2% moderate wear).

When percentages for each of the eight stages in Smith's (1984) method were estimated separately, the highest percentage of teeth was affected by stages 2 and the lowest percentage by stages 5, 6, 7 and 8. More specifically, the frequencies were the following: 1: 12.8%, 2: 49.7%, 3: 22.7%, 4: 9.9%, 5: 2.6%, 6: 1.9%, 7: 0.4%, and 8: 0.0%. When comparisons among the three age groups were made, it was revealed that frequencies steadily decreased with age in slight wear stage 1, and steadily increased with age in moderate wear stages 3, 4 and heavy wear stages 5 and 6. Slight wear stage 2 percentages increased from the first to the second age group but decreased in the third age group, whereas heavy wear stage 7 rates decreased from young to middle adults but again increased in older individuals. Rates for stage 8 were 0.0% in all age classes.

5.2.3 Within socioeconomic status (SES) groups

5.2.3.1 Demetrias

5.2.3.1.1 Low SES

A total number of 1755 low SES permanent teeth and 128 individuals were scored for occlusal attrition in Demetrias. All teeth (100.0%) and 128 individuals (100.0%) displayed signs of occlusal attrition, which ranged from slight wear of small areas of the enamel surface (stage 1 in Smith's (1984) method) to severe loss of crown height (stage 8 in Smith's (1984) method). Overall, 274 (15.6%) teeth showed slight wear (stages 1 and 2), 635 (36.2%) teeth showed moderate wear (stages 3 and 4), and 846 (48.2%) teeth showed heavy wear (stages 5 to 8). Slight and moderate wear rates decreased with age, whereas heavy wear frequency increased with age. More specifically, the overall (regardless of tooth type) wear frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were the following: (a) 31.8%,

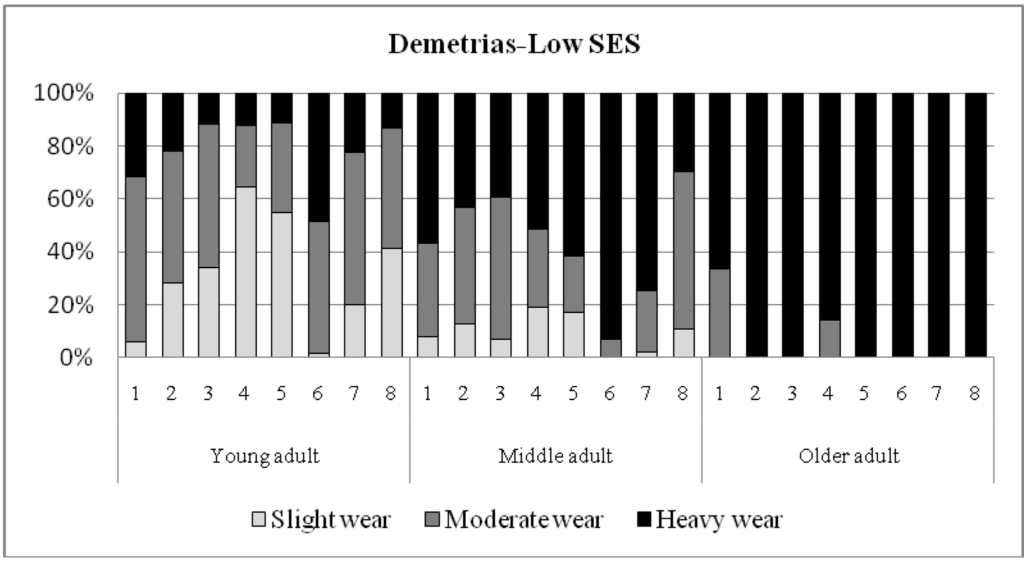

Figure 5.37: Frequency rates of teeth with slight, moderate and heavy wear for each tooth type (upper and lower dentition together), by age group, in the low SES group from Demetrias.

9.0% and 0.0% for slight wear, (b) 46.7%, 32.7% and 4.3% for moderate wear, and (c) 21.6%, 58.3%, and 95.7% for heavy wear, respectively.

In general, the teeth in the low SES population of Demetrias present a high frequency of heavy wear (Fig. 5.37). Analysis by tooth type, regardless of upper and lower dentition, revealed that first molars had heavy wear in 81.0% and were the most heavily worn teeth. Third molars displayed the lowest frequencies of heavy wear (24.8%). Mandibular teeth displayed higher frequencies of both heavy and moderate wear but lower frequencies of slight wear (13.4%, 37.7% and 48.9% for slight, moderate and heavy wear, respectively) than the maxillary ones (18.3%, 34.3% and 47.4% for slight, moderate and heavy wear, respectively), and the posterior teeth were more worn than the anterior ones. When maxillary and mandibular dentitions were considered separately, the most heavily worn teeth were the lower first molars, with 83.4% of them affected by heavy wear, whereas the least affected were the upper third molars (16.7%).

When percentages for each of the eight stages in Smith's (1984) method were estimated separately, the highest percentage of teeth was affected by stages 3, 4, 5 and 6, and the lowest percentage by stages 1 and 8. More specifically, the frequencies were the following: 1: 0.3%, 2: 15.3%, 3: 18.0%, 4: 18.2%, 5: 20.4%, 6: 16.6%, 7: 9.5%, and 8: 1.7%. When comparisons among the three age groups were made, it was revealed that frequencies steadily decreased with age in slight and moderate wear stages 1, 2, 3 and 4, and steadily increased with age in heavy wear stages 5, 6, 7 and 8.

5.2.3.1.2 High SES

A total number of 1640 high SES permanent teeth and 110 individuals were scored for occlusal attrition in Demetrias. All teeth (100.0%) and 110 individuals (100.0%) displayed signs of occlusal attrition, which ranged from slight wear of small areas of the enamel surface (stage 1 in Smith's (1984) method) to severe loss of crown height (stage 8 in Smith's (1984) method). Overall, 226 (13.8%) teeth showed slight wear (stages 1 and 2), 709 (43.2%) teeth showed moderate wear (stages 3 and 4), and 705 (43.0%) teeth showed heavy wear (stages 5 to 8). Slight and heavy wear rates increased from the first to the second age classes but decreased in the third age group; the latter difference was very marked for slight wear but very small for heavy wear. Moderate wear frequency steadily increased with age. More specifically, the overall (regardless of tooth type) wear frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were the following: (a) 26.5%, 51.7% and 21.7% for slight wear, (b) 8.5%, 44.5% and 47.0% for moderate wear, and (c) 6.1%, 43.5%, and 42.7% for heavy wear, respectively.

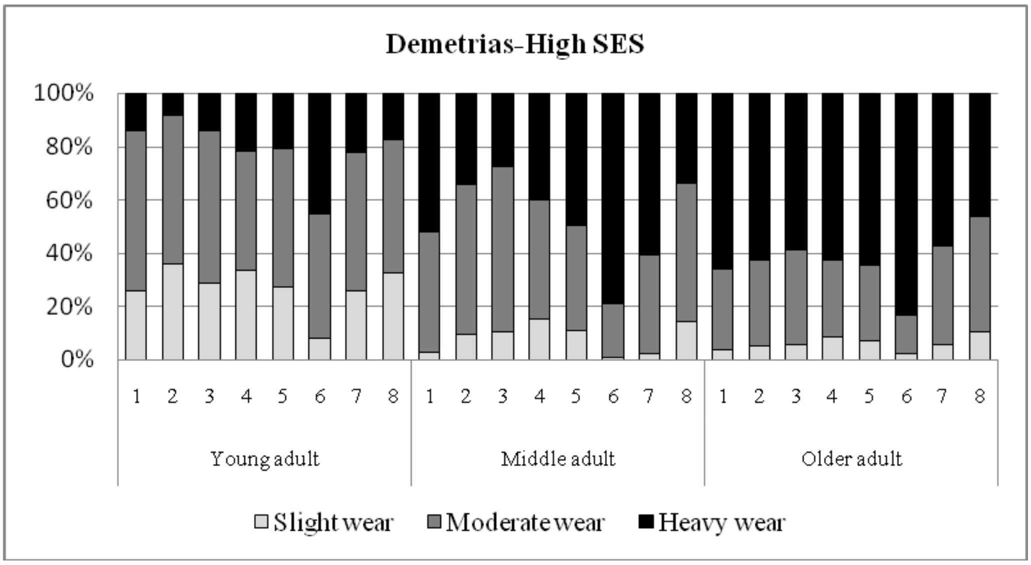

Figure 5.38: Frequency rates of teeth with slight, moderate and heavy wear for each tooth type (upper and lower dentition together), by age group, in the high SES group from Demetrias.

In general, the teeth in the high SES population of Demetrias present a high frequency of heavy wear (Fig. 5.38). Analysis by tooth type, regardless of upper and lower dentition, revealed that first molars had heavy wear in 66.8% and were the most heavily worn teeth. Third molars displayed the lowest frequencies of heavy wear (31.7%). Mandibular teeth displayed higher frequencies of and moderate wear only and lower frequencies of slight and heavy wear (10.9%, 46.4% and 42.7% for slight, moderate and heavy wear, respectively) than the maxillary ones (18.4%, 38.2% and 43.4% for slight, moderate and heavy wear, respectively), and the posterior teeth were more worn than the anterior ones. When maxillary and mandibular dentitions were considered separately, the most heavily worn teeth were the lower first molars, with 29.9% of them affected by heavy wear, whereas the least affected were the upper third molars (3.8%).

When percentages for each of the eight stages in Smith's (1984) method were estimated separately, the highest percentage of teeth was affected by stages 3, 4 and 5, and the lowest percentage by stages 1 and 8. More specifically, the frequencies were the following: 1: 1.6%, 2: 12.2%, 3: 17.3%, 4: 26.0%, 5: 20.0%, 6: 12.9%, 7: 8.5%, and 8: 1.6%. When comparisons among the three age groups were made, it was revealed that frequencies steadily decreased with age in slight wear stage 2 and moderate wear stage 3, and steadily increased with age in heavy wear stages 6, 7 and 8. The middle age class had the highest percentage of moderate wear stage 4 and heavy wear stage 5, whereas slight wear stages 1 decreased from the young to the middle age group and again increased in the older age group.

5.2.3.2 Athens

5.2.3.2.1 Low SES

A total number of 208 low SES permanent teeth and 20 individuals were scored for occlusal attrition in Athens. All teeth (100.0%) and 20 individuals (100.0%) displayed signs of occlusal attrition, which ranged from slight wear of small areas of the enamel surface (stage 1 in Smith's (1984) method) to severe loss of crown height (stage 8 in Smith's (1984) method). Overall, 145 (69.7%) teeth showed slight wear (stages 1 and 2), 51 (24.5%) teeth showed moderate wear (stages 3 and 4), and 12 (5.8%) teeth showed heavy wear (stages 5 to 8). Slight wear rates increased from the first to the second age class but greatly decreased in the older age group. Moderate and heavy wear rates decreased from the first to the second age group but markedly increased in older individuals. More specifically, the overall (regardless of tooth type) wear frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were the following: (a) 65.0%, 87.3% and 0.0% for slight wear, (b) 32.5%, 11.4% and 33.3% for moderate wear, and (c) 2.6%, 1.3%, and 66.7% for heavy wear, respectively.

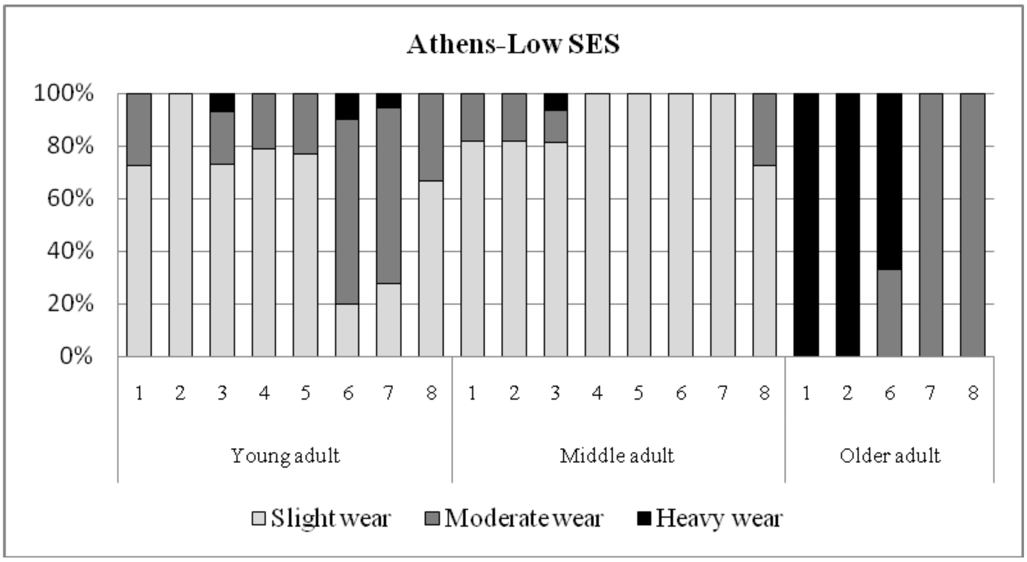

Figure 5.39: Frequency rates of teeth with slight, moderate and heavy wear for each tooth type (upper and lower dentition together), by age group, in the low SES group from Athens.

In general, the teeth in the low SES population of Athens present a low frequency of heavy wear (Fig. 5.39). Analysis by tooth type, regardless of upper and lower dentition, revealed that first molars had heavy wear in 16.7% and were the most heavily worn teeth. First premolars displayed the lowest frequencies of wear (0.0% heavy and 12.5% moderate wear). Mandibular teeth displayed higher frequencies of both moderate and heavy wear and slightly lower frequencies of slight wear (68.9%, 24.6% and 6.6% for slight, moderate and heavy wear, respectively) than the maxillary ones (70.9%, 24.4% and 4.7% for slight, moderate and heavy wear, respectively), but the differences were small. The anterior teeth were more worn than the posterior ones. When maxillary and mandibular dentitions were considered separately, the most heavily worn teeth were the lower first molars, with 42.9% of them affected by heavy wear, whereas the least affected were the upper canines (100.0% for slight, 0.0% for moderate and 0.0% for heavy wear).

When percentages for each of the eight stages in Smith's (1984) method were estimated separately, the highest percentage of teeth was affected by stages 2 and 3, and the lowest percentage by stages 5, 6, 7 and 8. More specifically, the frequencies were the following: 1: 8.7%, 2: 61.1%, 3: 18.3%, 4: 6.3%, 5: 3.8%, 6: 1.4%, 7: 0.5%, and 8: 0.0%. When comparisons among the three age groups were made, it was revealed that frequencies steadily decreased with age in moderate wear stage 3 and heavy wear stage 7, and steadily increased with age in heavy wear stage 6. The middle age class had the highest percentage of slight wear stages 1 and 2, whereas moderate wear stage 4 and heavy wear stage 5 decreased from the young to the middle age group and again increased in the older age group. Heavy wear stage 8 was not observed in any of the three age groups.

5.2.3.2.2 High SES

A total number of 129 high SES permanent teeth and 18 individuals were scored for occlusal attrition in Athens. All teeth (100.0%) and 18 individuals (100.0%) displayed signs of occlusal attrition, which ranged from slight wear of small areas of the enamel surface (stage 1 in Smith's (1984) method) to severe loss of crown height (stage 8 in Smith's (1984) method). Overall, 54 (41.9%) teeth showed slight wear (stages 1 and 2), 70 (54.3%) teeth showed moderate wear (stages 3 and 4), and 5 (3.9%) teeth showed heavy wear (stages 5 to 8). Slight wear rates decreased with age, whereas the opposite was the case for moderate and heavy wear. More specifically, the overall (regardless of tooth type) wear frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were the following: (a) 100.0%, 54.3% and 25.9% for slight wear, (b) 0.0%, 45.7% and 65.5% for moderate wear, and (c) 0.0%, 0.0%, and 8.6% for heavy wear, respectively.

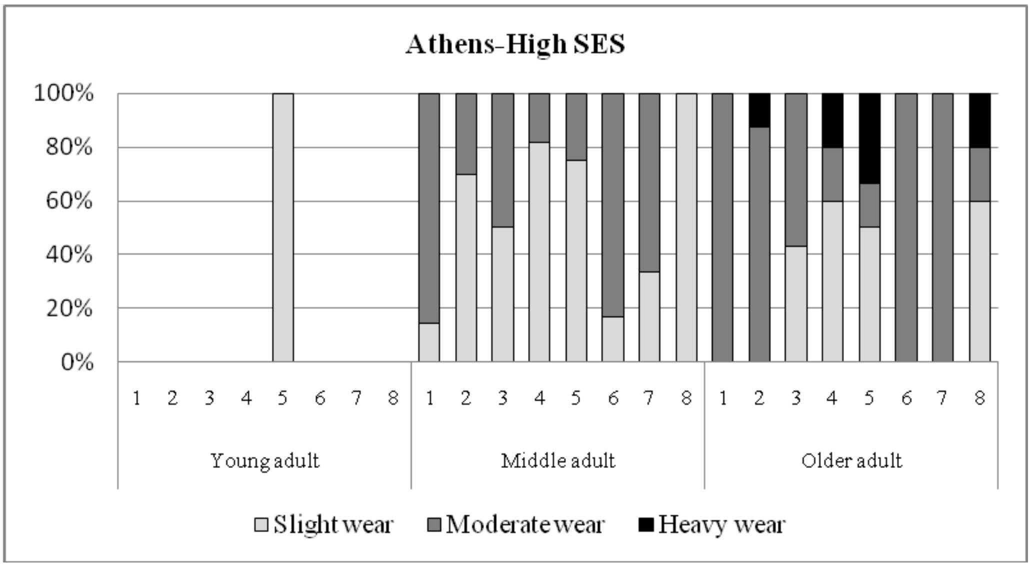

Figure 5.40: Frequency rates of teeth with slight, moderate and heavy wear for each tooth type (upper and lower dentition together), by age group, in the high SES group from Athens.

In general, the teeth in the high SES population of Athens present a low frequency of heavy wear (Fig. 5.40). Analysis by tooth type, regardless of upper and lower dentition, revealed that second premolars had heavy wear in 1.6% and were the most heavily worn teeth. First molars displayed the lowest frequencies of wear (0.0% heavy and 6.5% moderate wear). Mandibular teeth displayed higher frequencies of slight and moderate wear and lower frequencies of heavy wear (6.3%, 10.3% and 0.4% for slight, moderate and heavy wear, respectively) than the maxillary ones (4.7%, 3.9% and 0.6% for slight, moderate and heavy wear, respectively), and the posterior teeth were more worn than the anterior ones. When maxillary and mandibular dentitions were considered separately, the most heavily worn teeth were the upper second icisors, with only 1.7% of them affected by heavy wear, whereas the least affected were the upper third molars (4.8% for slight, 0.0% for moderate and 0.0% for heavy wear).

When percentages for each of the eight stages in Smith's (1984) method were estimated separately, the highest percentage of teeth was affected by stages 2 and 3, and the lowest percentage by stages 1, 5, 6, 7 and 8. More specifically, the frequencies were the following: 1: 1.6%, 2: 40.3%, 3: 40.3%, 4: 14.0%, 5: 0.8%, 6: 2.3%, 7: 0.8%, and 8: 0.0%. When comparisons among the three age groups were made, it was revealed that frequencies increased with age in moderate wear stage 4 and heavy wear stages 5, 6, 7 and 8. The middle age class had the highest percentage of slight wear stage 1 and moderate wear stage 3, whereas slight wear stage 2 rates decreased from the young to the middle age group and again increased in the older age group. Heavy wear stage 8 was not observed in any of the three age groups.

5.3 Periodontal Disease

With the purpose to facilitate the presentation of the results, the four (2 to 5) categories of the Kerr (1988) system were reduced to two groups. Thus, this section first reports overall and by age group frequencies for gingivitis and periodontitis. Comparisons between tooth types, upper and lower dentition and anterior and posterior teeth are also included. This section also presents the percentages for each one of the eight stages in Kerr's (1988) system and how these changed through the three age groups. All relevant information has already been discussed in the *Methodology* (*Chapter 4*), in sections 4.8.2. and 4.8.3.

5.3.1 Within populations

5.3.1.1 Demetrias

A total number of 584 interseptal areas and 74 individuals were examined for the presence of gingivitis and periodontitis; 128 (21.9%) interseptal areas, and 18

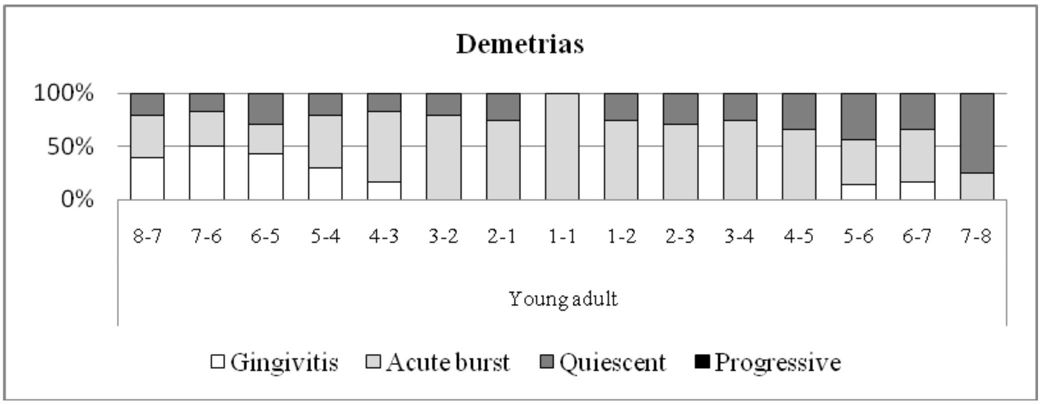

Figure 5.41a: Frequency rates of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in young adults, in Demetrias.

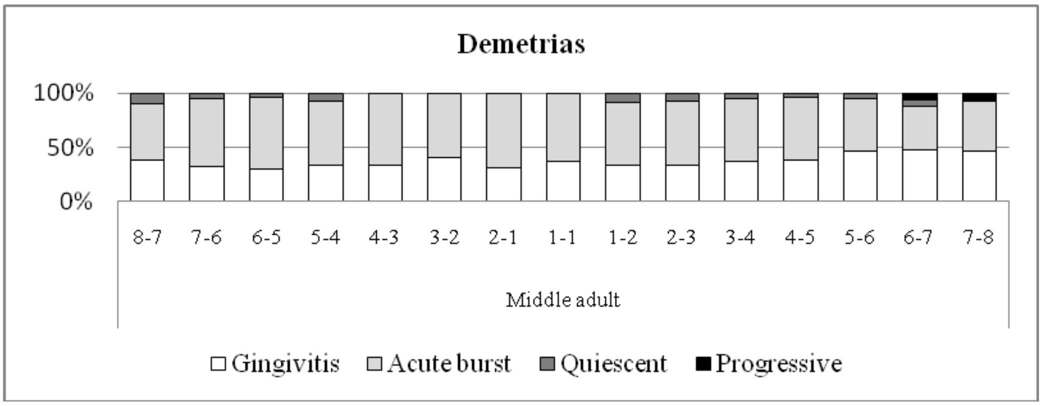

Figure 5.41b: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in middle adults, in Demetrias.

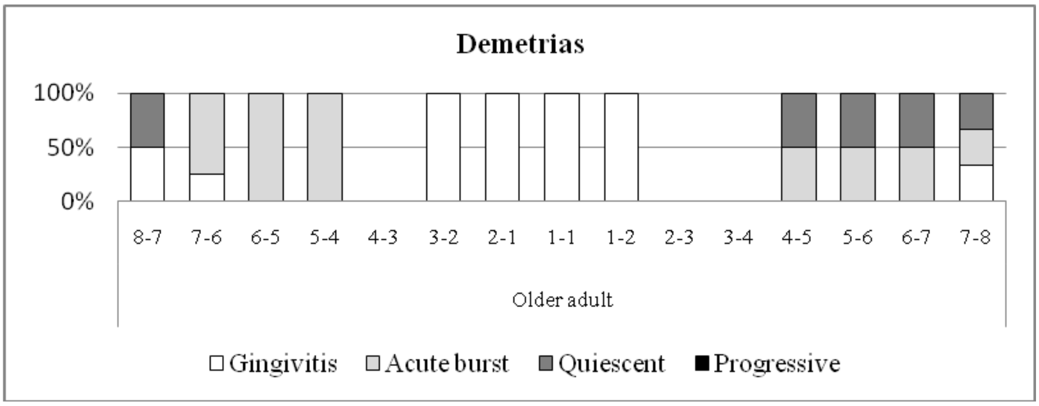

Figure 5.41c: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in older adults, in Demetrias.

(24.3%) individuals were affected by gingivitis (category 2), and 274 (46.9%) interseptal areas and 43 (58.1%) individuals by periodontitis (categories 3, 4 and 5). The overall frequencies (number of interseptal areas affected out of interseptal areas present and observable) for young, middle and older adults were, 7.1%, 29.4% and 29.2% for gingivitis, and 38.8%, 50.5%, and 58.3% for periodontitis, respectively. In total, out of 584 interseptal areas, 128 (21.9%) had gingivitis, 230 (39.4%) demonstrated the acute and 42 (7.2%) the quiescent phase of periodontitis, whereas only 2 (0.3%) displayed progressive periodontitis (Figs. 5.41a, 5.41b and 5.41c). Mandibular interseptal areas were more susceptible to gingivitis (24.6%) but less susceptible to periodontitis (37.8%) than maxillary areas (18.3% and 59.0%, respectively). Both gingivitis and periodontitis affected anterior interseptal areas (22.9% and 55.1%) more frequently than posterior areas (21.4% and 42.2%)(Figs. 5.41a, 5.41b and 5.41c). The distribution of lesions on the left and right sides of the dentition was very similar(Figs. 5.41a, 5.41b and 5.41c).

5.3.1.2 Athens

A total number of 1369 interseptal areas and 105 individuals were examined for the presence of gingivitis and periodontitis; 453 (33.1%) interseptal areas, and 25 (23.8%) individuals were affected by gingivitis, and 839 (61.3%) interseptal areas and 79 (75.2%) individuals by periodontitis. The overall frequencies (number of interseptal areas affected out of interseptal areas present and observable) for young, middle and older adults were 60.4%, 16.1% and 24.2% for gingivitis, and 25.6%, 82.5% and 74.6% for periodontitis, respectively. In total, out of 1369 interseptal areas, 453 (33.1%) had gingivitis, 798 (58.3%) demonstrated the acute and 35 (2.6%) the quiescent phase of periodontitis, whereas only 6 (0.4%) displayed progressive periodontitis (Figs. 5.42a, 5.42b and 5.42c). Mandibular interseptal areas were slightly more susceptible to gingivitis (34.5%) but less susceptible to periodontitis (60.7%) than maxillary areas (31.3% and 62.1%,

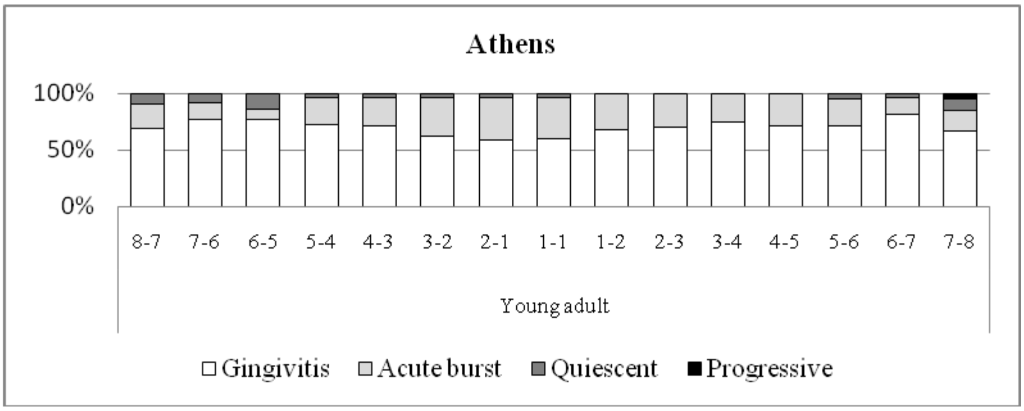

Figure 5.42a: Frequency rates of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in young adults, in Athens.

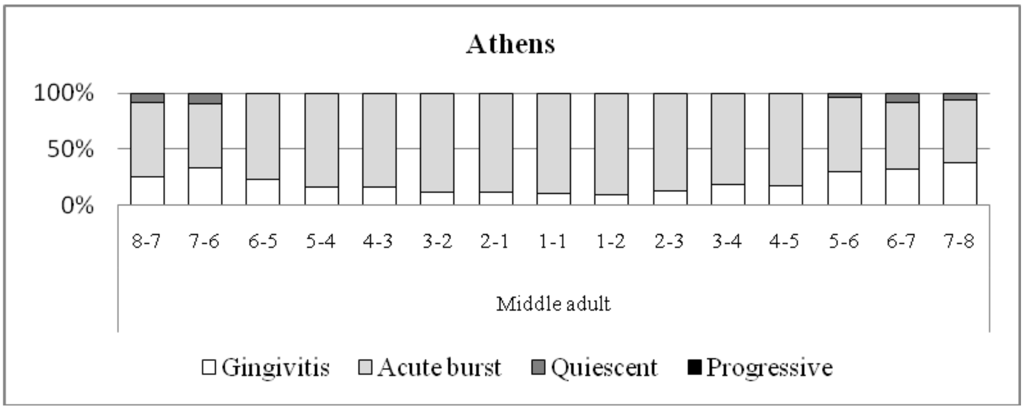

Figure 5.42b: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in middle adults, in Athens.

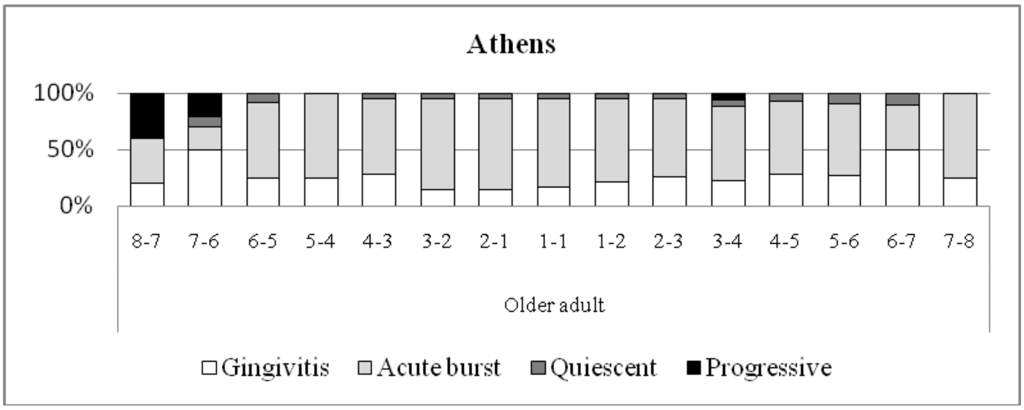

Figure 5.42c: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in older adults, in Athens.

respectively). Gingivitis affected posterior interseptal areas (44.3%) more frequently than anterior areas (23.8%), whereas the opposite was the case for periodontitis (70.7% and 49.4% for anterior and posterior, respectively) (Figs. 5.42a, 5.42b and 5.42c). The distribution of lesions on the left and right sides of the dentition was very similar (Figs. 5.42a, 5.42b and 5.42c).

5.3.2 Within sexes

5.3.2.1 Demetrias

5.3.2.1.1 Females

A total number of 254 interseptal areas and 25 individuals were examined for the presence of gingivitis and periodontitis; 64 (25.2%) interseptal areas, and 4 (16.0%) individuals were affected by gingivitis, and 124 (48.8%) interseptal areas and 16 (64.0%) individuals by periodontitis. The overall frequencies (number of interseptal areas affected out of interseptal areas present and observable) for young, middle and older adults were 8.8%, 36.8% and 0.0% for gingivitis, and 45.1%, 48.7% and 81.8% for periodontitis, respectively. In total, out of 254 interseptal areas, 64 (25.2%) had gingivitis, 119 (46.9%) demonstrated the acute and 5 (2.0%) the quiescent phase of periodontitis, whereas none (0.0%) displayed progressive periodontitis (Figs. 5.43a, 5.43b and 5.43c). Mandibular interseptal areas were more susceptible to gingivitis (26.2%) but significantly less susceptible to periodontitis (40.5%) than maxillary areas (24.2% and 57.0%, respectively). Both gingivitis and periodontitis affected anterior interseptal areas (28.1% and 52.6%) more frequently than posterior areas (23.1% and 46.3%) (Figs. 5.43a, 5.43b and 5.43c). The distribution of lesions on the left and right sides of the dentition was very similar (Figs. 5.43a, 5.43b and 5.43c).

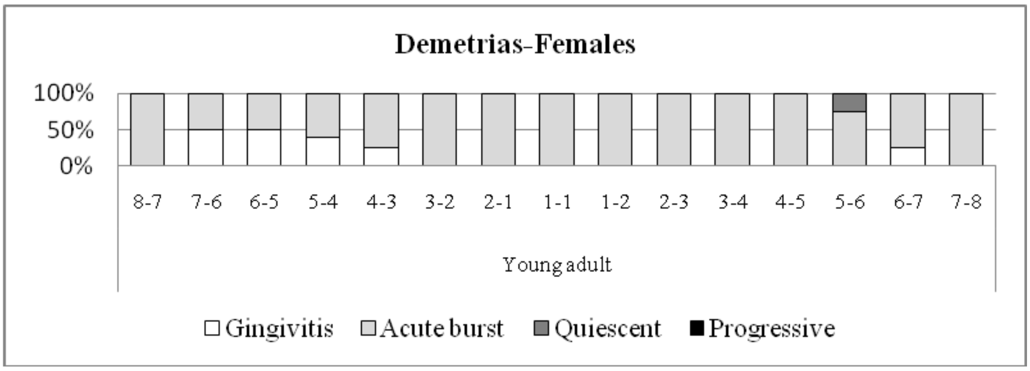

Figure 5.43a: Frequency rates of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in young adult females from Demetrias.

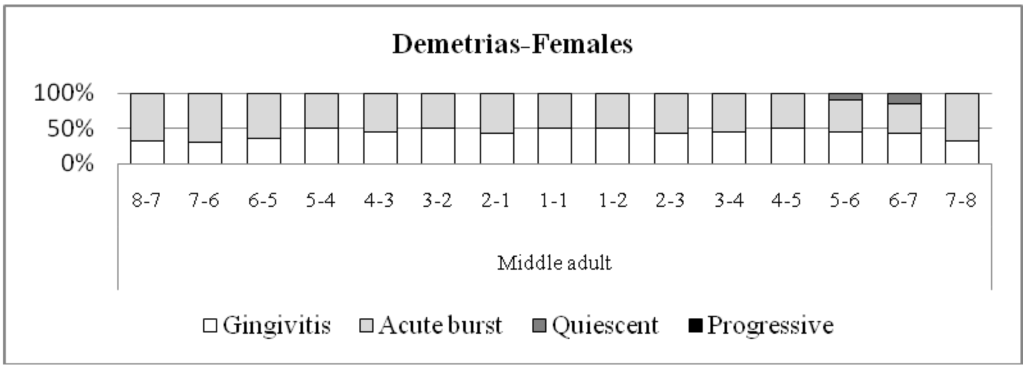

Figure 5.43b: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in middle adult females from Demetrias.

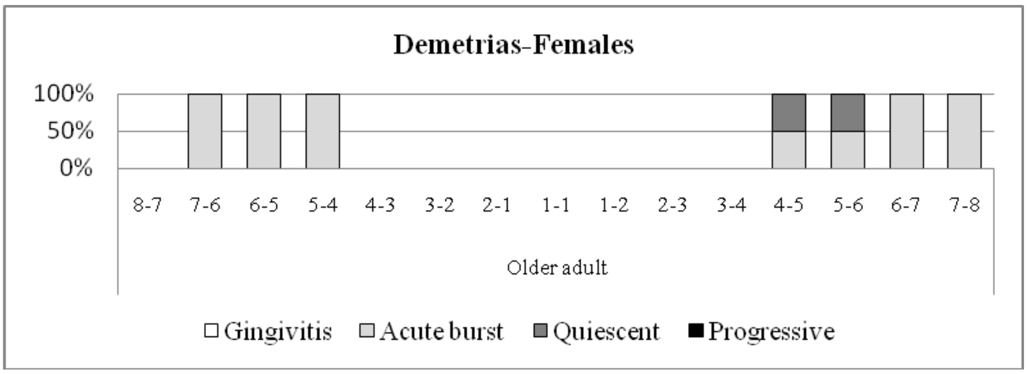

Figure 5.43c: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in older adult females from Demetrias.

5.3.2.1.2 Males

A total number of 330 interseptal areas and 49 individuals were examined for the presence of gingivitis and periodontitis; 64 (19.4%) interseptal areas, and 14 (28.6%) individuals were affected by gingivitis, and 150 (45.5%) interseptal areas and 27 (55.1%) individuals by periodontitis. The overall frequencies (number of interseptal areas affected out of interseptal areas present and observable) for young, middle and older adults were 5.7%, 24.1% and 53.8% for gingivitis, and 33.3%, 51.9% and 38.5% for periodontitis, respectively. In total, out of 330 interseptal areas, 64 (19.4%) had gingivitis, 11 (33.6%) demonstrated the acute and 37 (11.2%) the quiescent phase of periodontitis, whereas only 2 (0.6%) displayed progressive periodontitis (Figs. 5.44a, 5.44b and 5.44c). Mandibular interseptal areas were more susceptible to gingivitis (23.7%) but less susceptible to periodontitis (36.2%) than maxillary areas (12.2% and 61.0%, respectively). Gingivitis affected posterior interseptal areas (20.2%) more frequently than anterior areas (18.0%), whereas the opposite was the case for periodontitis (57.4% and 39.5% for anterior and posterior, respectively) (Figs. 5.44a, 5.44b and 5.44c). The distribution of lesions on the left and right sides of the dentition was very similar (Figs. 5.44a, 5.44b and 5.44c).

5.3.2.2 Athens

5.3.2.2.1 Females

A total number of 660 interseptal areas and 49 individuals were examined for the presence of gingivitis and periodontitis; 185 (28.0%) interseptal areas, and 13 (26.5%) individuals were affected by gingivitis, and 423 (64.1%) interseptal areas and 35 (71.4%) individuals by periodontitis. The overall frequencies (number of interseptal areas affected out of interseptal areas present and observable) for young, middle and older adults were 59.0%, 13.6% and 23.0% for gingivitis, and

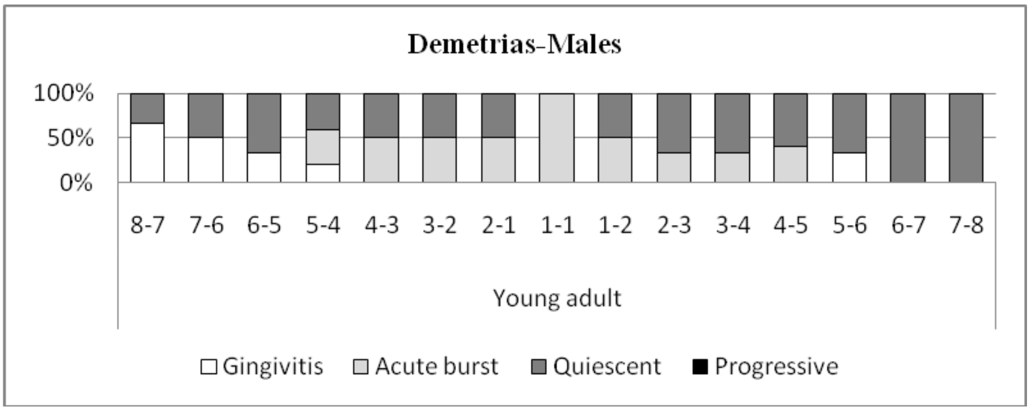

Figure 5.44a: Frequency rates of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in young adult males from Demetrias.

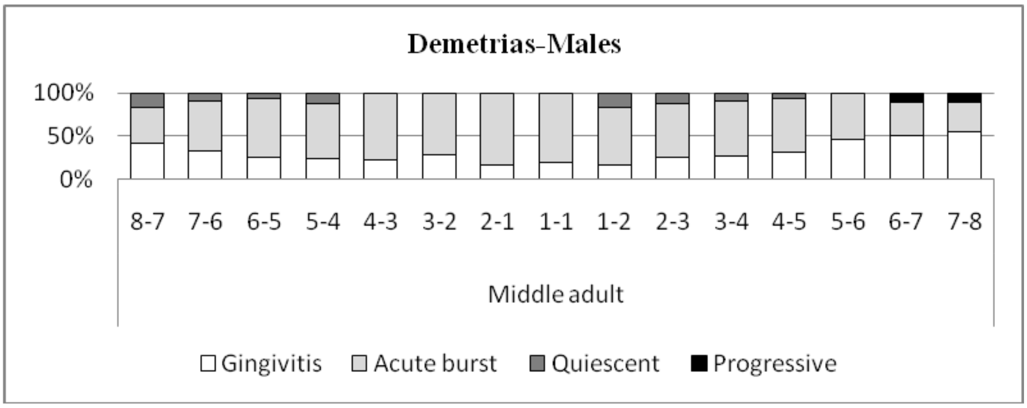

Figure 5.44b: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in middle adult males from Demetrias.

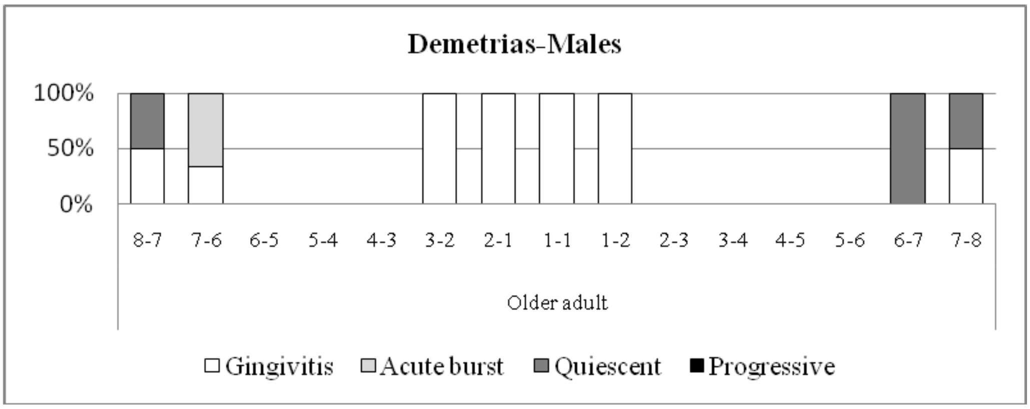

Figure 5.44c: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in older adult males from Demetrias.

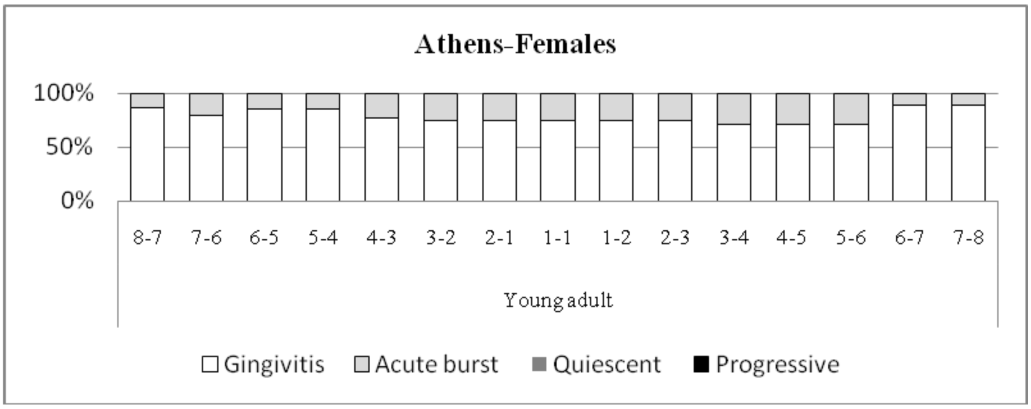

Figure 5.45a: Frequency rates of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in young adult females from Athens.

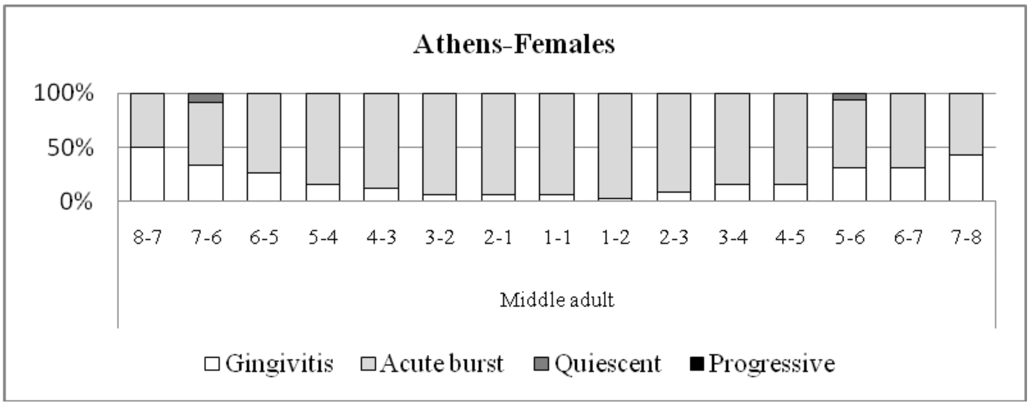

Figure 5.45b: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in middle adult females from Athens.

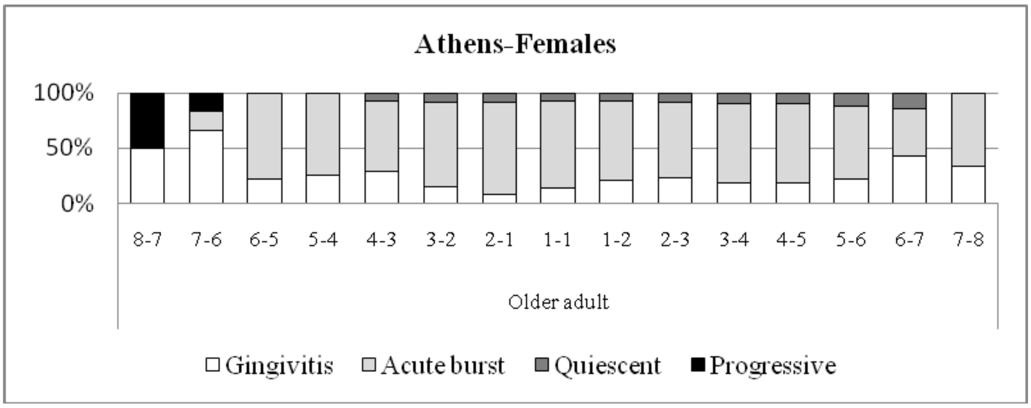

Figure 5.45c: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in older adult females from Athens.

15.5%, 83.7% and 75.7% for periodontitis, respectively. In total, out of 660 interseptal areas, 185 (28.0%) had gingivitis, 409 (62.0%) demonstrated the acute and 12 (1.8%) the quiescent phase of periodontitis, whereas only 2 (0.3%) displayed progressive periodontitis (Figs. 5.45a, 5.45b and 5.45c). Mandibular interseptal areas were more susceptible to periodontitis (29.5%) than maxillary areas (26.2%) but equally susceptible to gingivitis (64.1%). Gingivitis affected posterior interseptal areas (41.4%) more frequently than anterior areas (17.0%), whereas the opposite was the case for periodontitis (75.3% and 50.2%, for anterior and posterior, respectively). The distribution of lesions on the left and right sides of the dentition was very similar (Figs. 5.45a, 5.45b and 5.45c).

5.3.2.2.2 Males

A total number of 709 interseptal areas and 56 individuals were examined for the presence of gingivitis and periodontitis; 268 (37.8%) interseptal areas, and 12 (21.4%) individuals were affected by gingivitis, and 416 (58.7%) interseptal areas and 44 (78.6%) individuals by periodontitis. The overall frequencies (number of interseptal areas affected out of interseptal areas present and observable) for young, middle and older adults were 61.2%, 18.7% and 26.2% for gingivitis, and 30.9%, 81.3% and 72.6% for periodontitis, respectively. In total, out of 709 interseptal areas, 268 (37.8%) had gingivitis, 389 (54.9%) demonstrated the acute and 23 (3.2%) the quiescent phase of periodontitis, whereas only 4 (0.6%) displayed progressive periodontitis (Figs. 5.46a, 5.46b and 5.46c). Mandibular interseptal areas were slightly more susceptible to gingivitis (38.9%) but less susceptible to periodontitis (57.7%) than maxillary areas (36.3% and 60.0%, respectively). Gingivitis affected posterior interseptal areas (47.1%) more frequently than anterior areas (30.1%), whereas the opposite was the case for periodontitis (66.6% and 48.7% for anterior and posterior, respectively) (Figs.

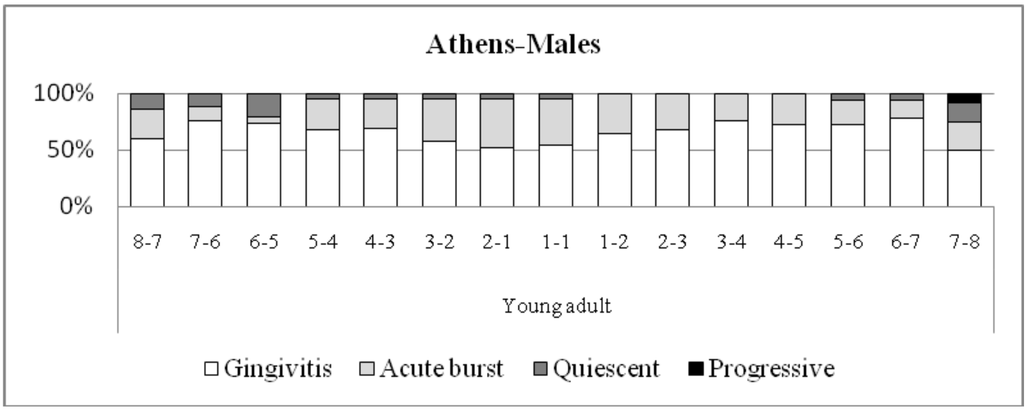

Figure 5.46a: Frequency rates of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in young adult males from Athens.

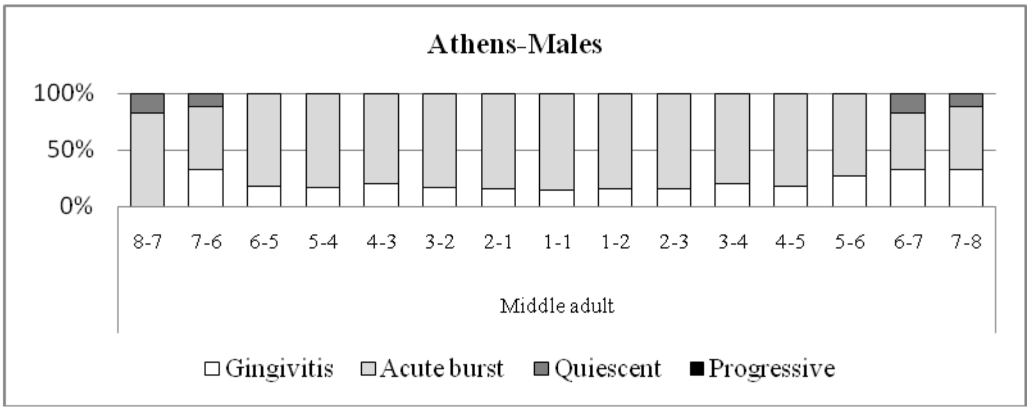

Figure 5.46b: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in middle adult males from Athens.

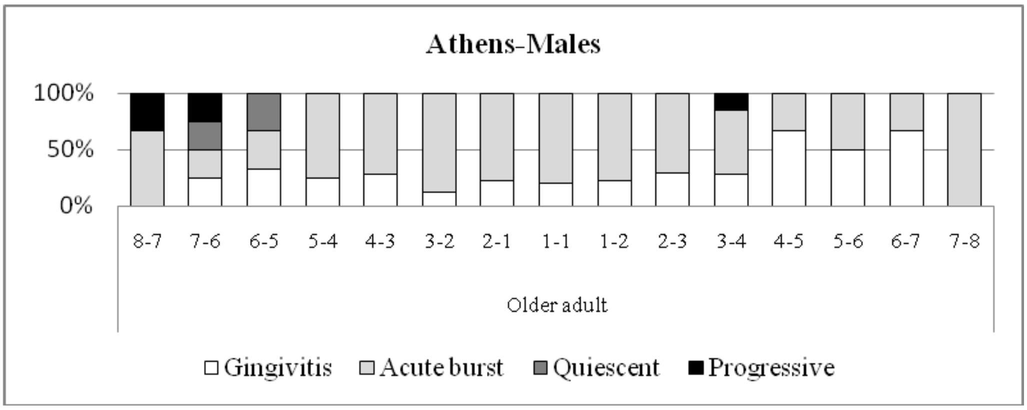

Figure 5.46c: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in older adult males from Athens.

5.46a, 5.46b and 5.46c). The distribution of lesions on the left and right sides of the dentition was very similar (Figs. 5.46a, 5.46b and 5.46c).

5.3.3 Within socioeconomic status (SES) groups

5.3.3.1 Demetrias

5.3.3.1.1 Low SES

A total number of 312 interseptal areas and 37 individuals were examined for the presence of gingivitis and periodontitis; 31 (9.9%) interseptal areas, and 3 (8.1%) individuals were affected by gingivitis, and 222 (71.2%) interseptal areas and 29 (78.4%) individuals by periodontitis. The overall frequencies (number of interseptal areas affected out of interseptal areas present and observable) for young, middle and older adults were 0.0%, 13.4% and 0.0% for gingivitis, and 87.3%, 65.5% and 100.0% for periodontitis, respectively. In total, out of 312 interseptal areas, 31 (9.9%) had gingivitis, 193 (61.9%) demonstrated the acute and 27 (8.7%) the quiescent phase of periodontitis, whereas only 2 (0.6%) displayed progressive periodontitis (Figs. 5.47a, 5.47b and 5.47c). Mandibular interseptal areas were more susceptible to gingivitis (17.0%) but less susceptible to periodontitis (56.9%) than maxillary areas (3.1% and 84.9%, respectively). Gingivitis affected posterior interseptal areas (12.6%) more frequently than anterior areas (0.0%), whereas the opposite was the case for periodontitis (98.3% and 60.4% for anterior and posterior, respectively) (Figs. 5.47a, 5.47b and 5.47c). The distribution of lesions on the left and right sides of the dentition was very similar (Figs. 5.47a, 5.47b and 5.47c).

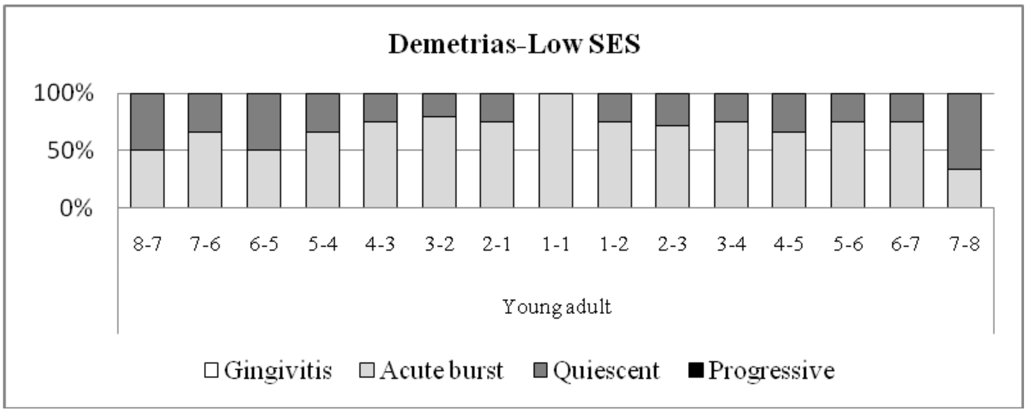

Figure 5.47a: Frequency rates of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in young adults, in the low SES group from Demetrias.

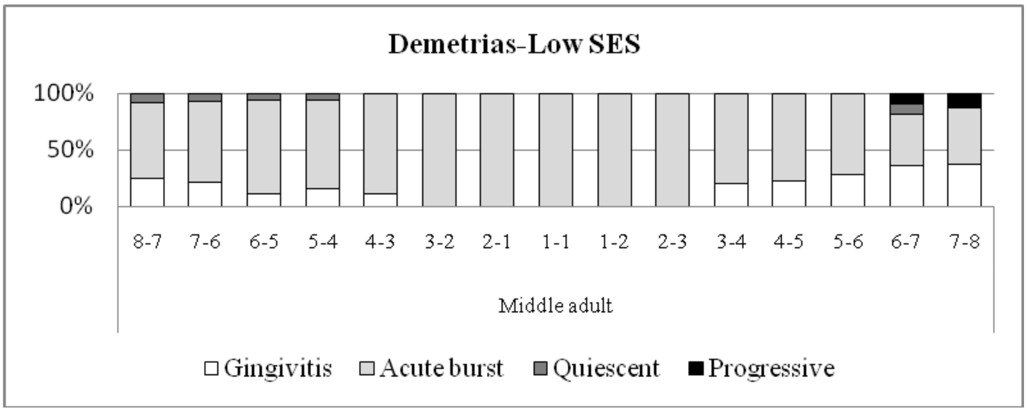

Figure 5.47b: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in middle adults, in the low SES group from Demetrias.

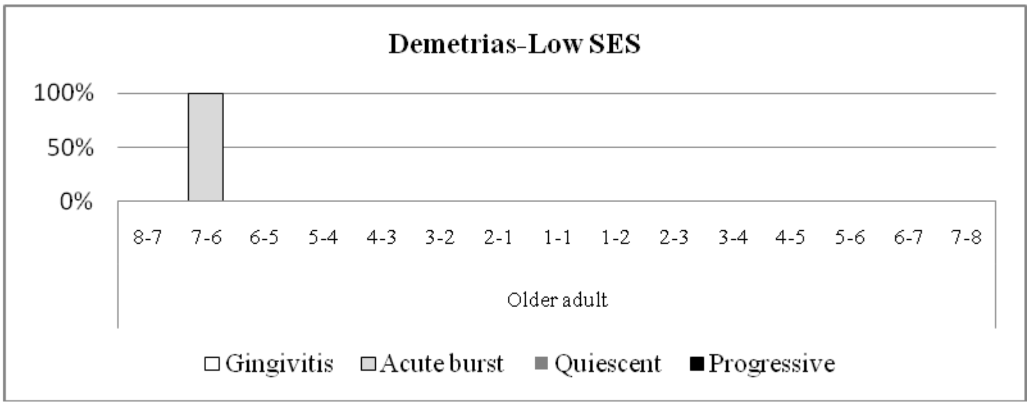

Figure 5.47c: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in older adults, in the low SES group from Demetrias.

5.3.3.1.2 High SES

A total number of 272 interseptal areas and 37 individuals were examined for the presence of gingivitis and periodontitis; 97 (35.7%) interseptal areas, and 15 (40.5%) individuals were affected by gingivitis, and 52 (19.1%) interseptal areas and 14 (37.8%) individuals by periodontitis. The overall frequencies (number of interseptal areas affected out of interseptal areas present and observable) for young, middle and older adults were 12.0%, 57.6% and 30.4% for gingivitis, and 6.0%, 24.2% and 56.5% for periodontitis, respectively. In total, out of 272 interseptal areas, 97 (35.7%) had gingivitis, 37 (13.6%) demonstrated the acute and 15 (5.5%) the quiescent phase of periodontitis, whereas none (0.0%) displayed progressive periodontitis (Figs. 5.48a, 5.48b and 5.48c). Maxillary interseptal areas were more susceptible to gingivitis (44.6%) but less susceptible to periodontitis (14.1%) than maxndibular areas (31.1% and 21.7%, respectively). Gingivitis affected anterior interseptal areas (45.8%) more frequently than posterior areas (31.2%), whereas the opposite was the case for periodontitis (11.9% and 22.0% for anterior and posterior, respectively) (Figs. 5.48a, 5.48b and 5.48c). The distribution of lesions on the left and right sides of the dentition was very similar (Figs. 5.48a, 5.48b and 5.48c).

5.3.3.2 Athens

5.3.3.2.1 Low SES

A total number of 255 interseptal areas and 19 individuals were examined for the presence of gingivitis and periodontitis; 113 (44.3%) interseptal areas, and 4 (21.1%) individuals were affected by gingivitis, and 135 (52.9%) interseptal areas and 15 (78.9%) individuals by periodontitis. The overall frequencies (number of interseptal areas affected out of interseptal areas present and observable) for young, middle and older adults were 61.0%, 22.9% and 0.0% for gingivitis, and

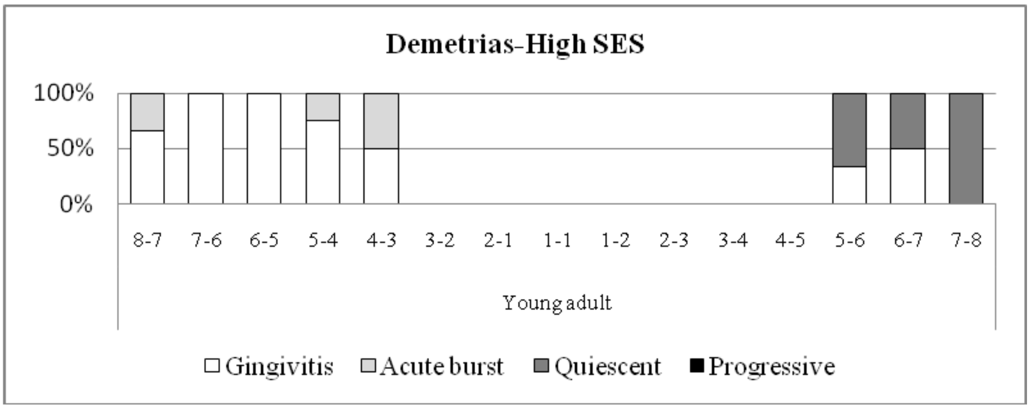

Figure 5.48a: Frequency rates of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in young adults, in the high SES group from Demetrias.

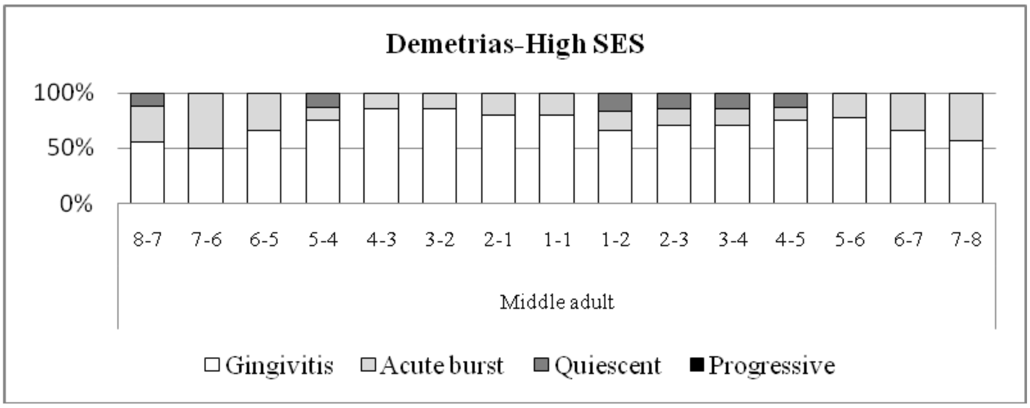

Figure 5.48b: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in middle adults, in the high SES group from Demetrias.

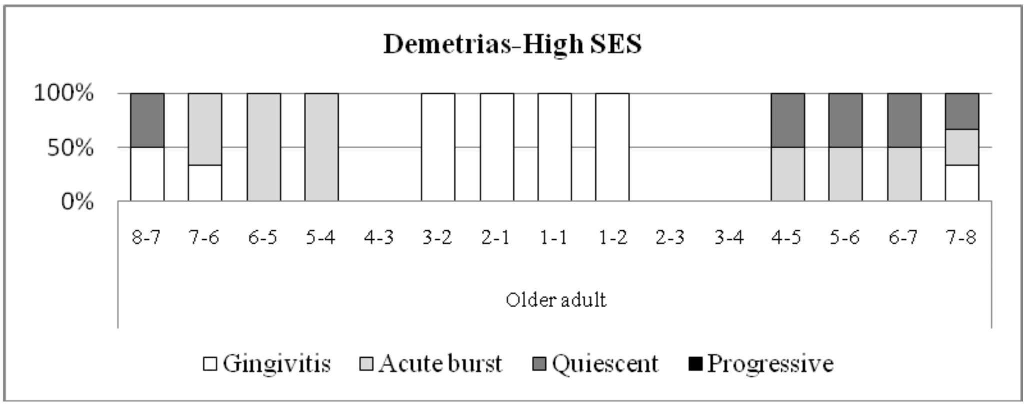

Figure 5.48c: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in older adults, in the high SES group from Demetrias.

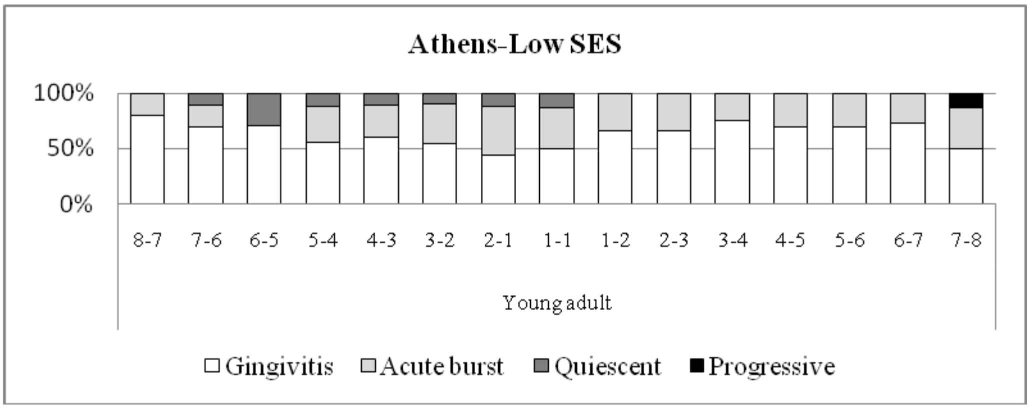

Figure 5.49a: Frequency rates of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in young adults, in the low SES group from Athens.

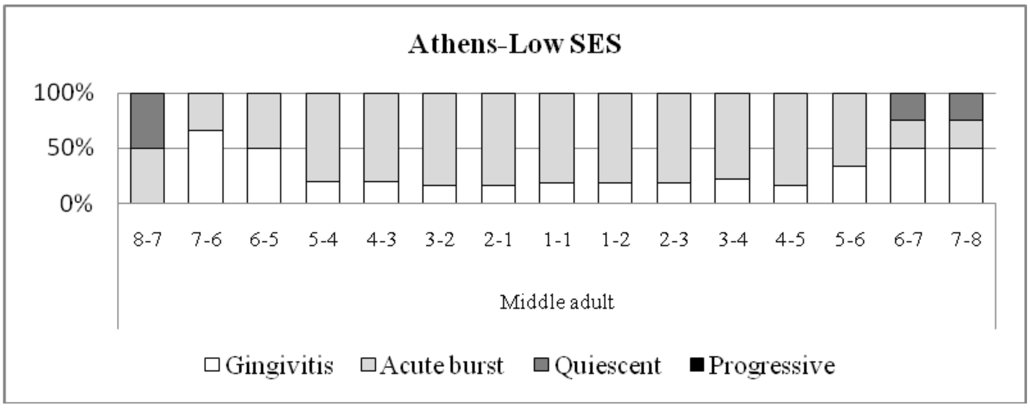

Figure 5.49b: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in middle adults, in the low SES group from Athens.

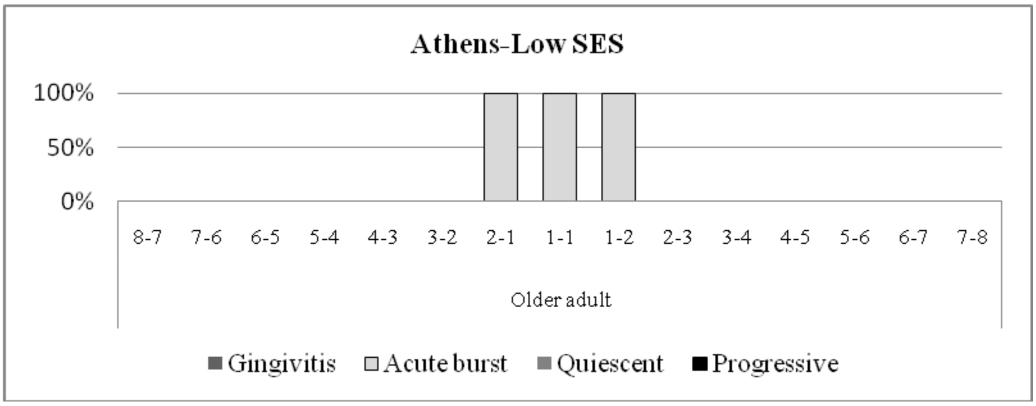

Figure 5.49c: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in older adults, in the low SES group from Athens.

34.2%, 77.1% and 100.0% for periodontitis, respectively. In total, out of 255 interseptal areas, 113 (44.3%) had gingivitis, 123 (48.2%) demonstrated the acute and 11 (4.3%) the quiescent phase of periodontitis, whereas only 1 (0.4%) displayed progressive periodontitis (Figs. 5.49a, 5.49b and 5.49c). Mandibular interseptal areas were more susceptible to gingivitis (46.9%) but less susceptible to periodontitis (49.0.%) than maxillary areas (41.1% and 58.0%, respectively). Gingivitis affected posterior interseptal areas (58.1%) more frequently than anterior areas (32.1%), whereas the opposite was the case for periodontitis (63.4% and 41.0% for anterior and posterior, respectively). The distribution of lesions on the left and right sides of the dentition was very similar (Figs. 5.49a, 5.49b and 5.49c).

5.3.3.2.2 High SES

A total number of 176 interseptal areas and 16 individuals were examined for the presence of gingivitis and periodontitis; 64 (36.4%) interseptal areas, and 3 (18.8%) individuals were affected by gingivitis, and 110 (62.5%) interseptal areas and 13 (81.3%) individuals by periodontitis. The overall frequencies (number of interseptal areas affected out of interseptal areas present and observable) for young, middle and older adults were 60.0%, 41.2% and 26.3% for gingivitis, and 40.0%, 57.6% and 72.4% for periodontitis, respectively. In total, out of 176 interseptal areas, 64 (36.4%) had gingivitis, 104 (59.1%) demonstrated the acute and 3 (1.7%) the quiescent phase of periodontitis, whereas 3 (1.7%) displayed progressive periodontitis (Figs. 5.50a, 5.50b and 5.50c). Mandibular interseptal areas were more susceptible to gingivitis (40.9%) but less susceptible to periodontitis (58.2%) than maxillary areas (28.8% and 69.7%, respectively). Gingivitis affected posterior interseptal areas (37.7%) more frequently than anterior areas (34.1%), whereas the opposite was the case for periodontitis (64.8% and 60.4% for anterior and posterior, respectively) (Figs. 5.50a, 5.50b and

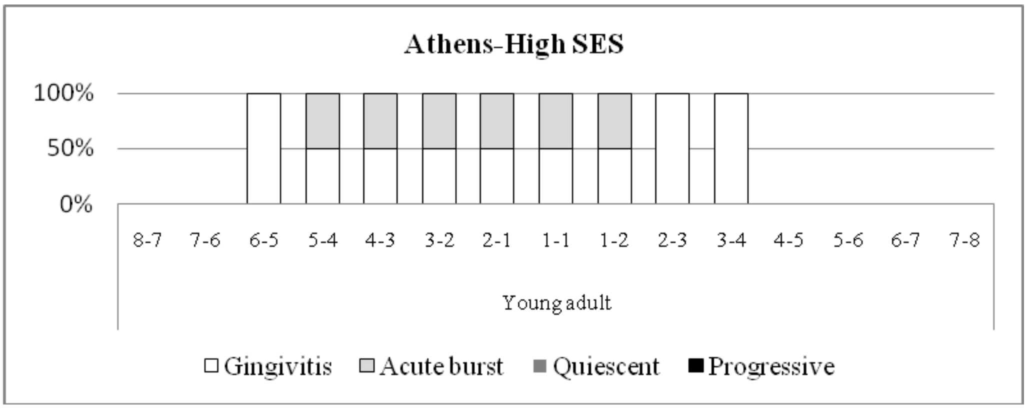

Figure 5.50a: Frequency rates of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in young adults, in the high SES group from Athens.

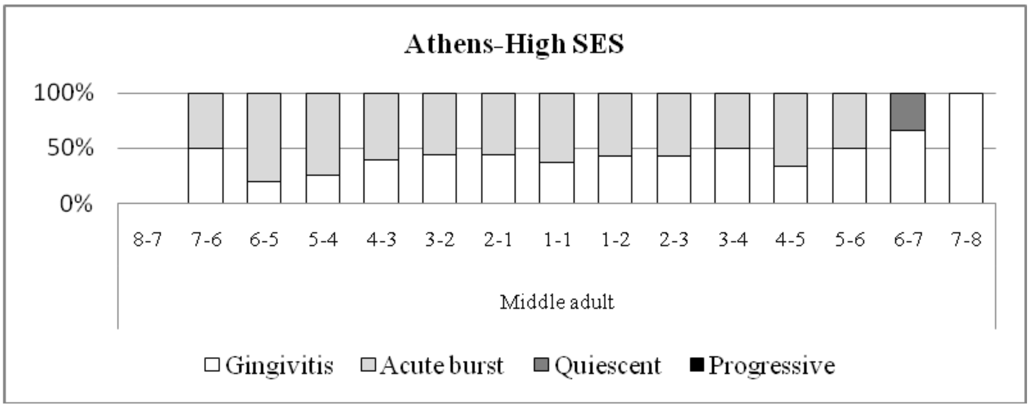

Figure 5.50b: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in middle adults, in the high SES group from Athens.

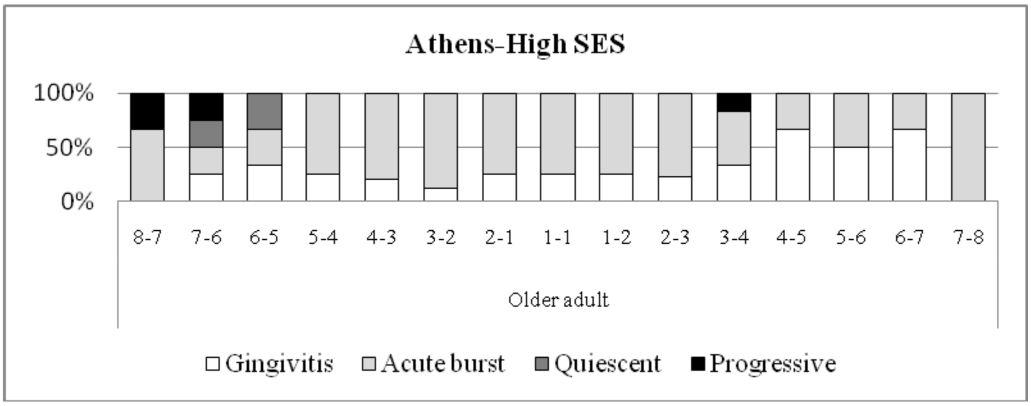

Figure 5.50c: Frequency rates of teeth with gingivitis, acute burst, quiescent phase and progressive periodontitis for each tooth type (upper and lower dentition together), in older adults, in the high SES group from Athens.

5.50c). The distribution of lesions on the left and right sides of the dentition was very similar (Figs. 5.50a, 5.50b and 5.50c).

5.4 Dental Defects of Enamel

This section reports the overall (regardless of defect type and tooth region) frequencies of dental defects of enamel (DDE), the percentages of tooth regions affected, and the prevalence of furrow-like, pit defects and plane-form defects. All the these frequencies are also presented by age group. Comparisons between tooth types, upper and lower dentition, and anterior and posterior teeth are also included. All relevant information can be found in the *Methodology* (*Chapter 4*), in sections 4.9.2. and 4.9.3.

5.4.1 Within populations

5.4.1.1 Demetrias

A total number of 1261 permanent teeth and 103 individuals were examined for the presence of dental defects of enamel (DDE); 415 (32.9%) teeth and 56 (54.4%) individuals were affected. The overall (regardless of defect type and tooth region) DDE frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were 36.1%, 37.4% and 13.8%, respectively.

The most frequently affected tooth region was the cervical area (31.4%), followed by the contact area (30.9%) and the occlusal region (0.2%). In total, 20.9% of the areas (cervical, contact and occlusal) observed, were affected by furrow-like defects, and 0.7% by bands of pitted defects; no plane-form defects were

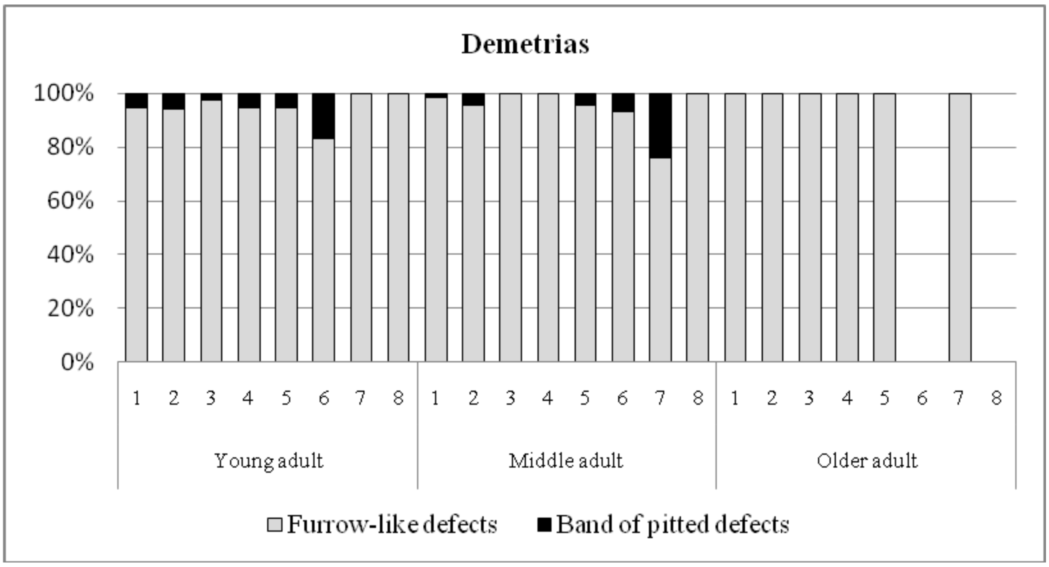

Figure 5.51: Frequency rates of tooth regions with furrow-like and band of pitted defects of enamel for each tooth type (upper and lower dentition together), by age group, in Demetrias.

observed in the sample (Fig. 5.51). Furrow-like defects rates increased from young (21.3%) to middle adults (24.2%) but significantly decreased in the older age group (10.5%) (Fig. 5.51). For pit defects, the frequencies were 1.1%, 0.7% and 0.0% for young, middle and older individuals, respectively (Fig. 5.51).

Furrow-like and pit defects were observed in 0.1% and 0.1% of the occlusal, 30.0% and 0.9% of the contact, and 30.6% and 0.8% of the cervical areas of the sample, respectively. The most frequently affected tooth types (upper and lower together) for furrow-like and pit defects were canines (0.5%) and first molars (0.8%) for the occlusal area, canines (53.3%) and second incisors (2.2%) for the contact area, and canines (54.6%) and second molars (1.9%) for the cervical region, respectively. Furrow-like defects affected the lower (21.6%) dentition more frequently the upper (20.0%), whereas the opposite was the case for pit defects (0.8% and 0.6% for maxillary and mandibular teeth, respectively).

5.4.1.2 Athens

A total number of 894 permanent teeth and 106 individuals were examined for the presence of DDE; 196 (21.9%) teeth and 47 (44.3%) individuals were affected. The overall (regardless of defect type and tooth region) DDE frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were 19.9%, 20.7% and 29.5%, respectively.

The most frequently affected tooth region was the cervical area (20.9%), followed by the contact area (19.2%) and the occlusal region (0.9%). In total, 14.0% of the areas (cervical, contact and occlusal) observed, were affected by furrow-like defects, and 0.9% by bands of pitted defects; no plane-form defects were observed in the sample (Fig. 5.52). Furrow-like defects rates decreased from young (14.7%) to middle adults (11.2%) and rose to 19.3% in older individuals (Fig. 5.52). For pit defects, the frequencies were 0.2%, 1.7% and 0.4% for young, middle and older individuals, respectively (Fig. 5.52).

Furrow-like and pit defects were observed in 0.4% and 0.5% of the occlusal, 18.2% and 1.0% of the contact, and 19.7% and 1.1% of the cervical areas of the sample, respectively. The most frequently affected tooth types (upper and lower together) for furrow-like and pit defects were first incisors (1.3%) and first premolars and molars (1.0%) for the occlusal area, first incisors (39.3%) and second premolars (3.3%) for the contact area, and first incisors (39.5%) and canines (3.5%) for the cervical region, respectively. Furrow-like defects affected the lower (19.0%) dentition more frequently the upper (7.6%), whereas the opposite was the case for pit defects (1.1% and 0.7% for maxillary and mandibular teeth, respectively).

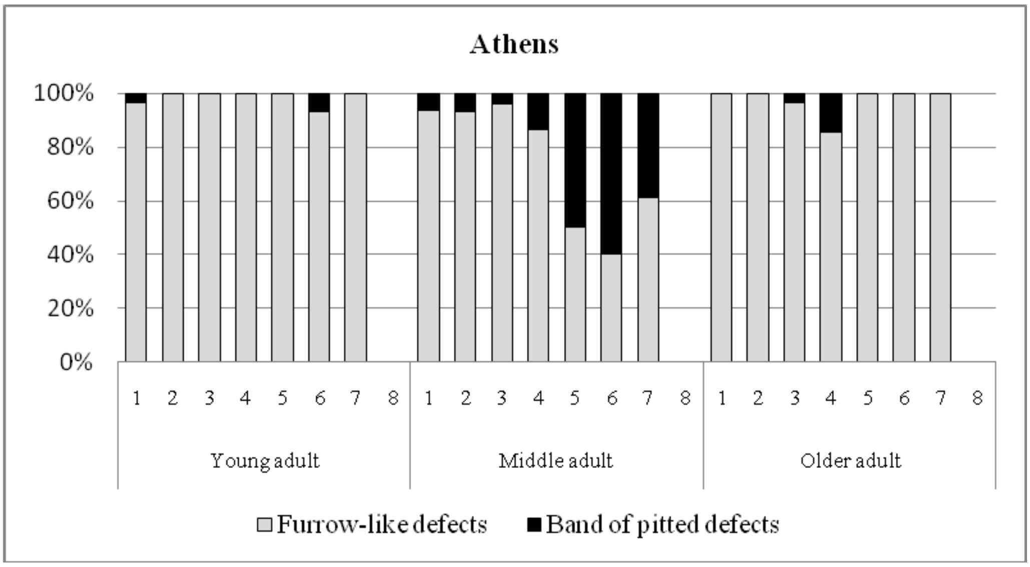

Figure 5.52: Frequency rates of tooth regions with furrow-like and band of pitted defects of enamel for each tooth type (upper and lower dentition together), by age group, in Athens.

5.4.2 Within sexes

5.4.2.1 Demetrias

5.4.2.1.1 Females

In the whole female assemblage from Demetrias, a total number of 464 teeth and 37 individuals were examined for the presence of DDE; 160 (34.5%) teeth and 17 (45.9%) individuals were affected. The overall (regardless of defect type and tooth region) DDE frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were 32.9%, 48.1% and 8.8%, respectively.

The most frequently affected tooth region was the cervical area (34.4%), followed by the contact area (31.1%) and the occlusal region (0.2%). In total, 21.3% of the areas (cervical, contact and occlusal) observed, were affected by furrow-like

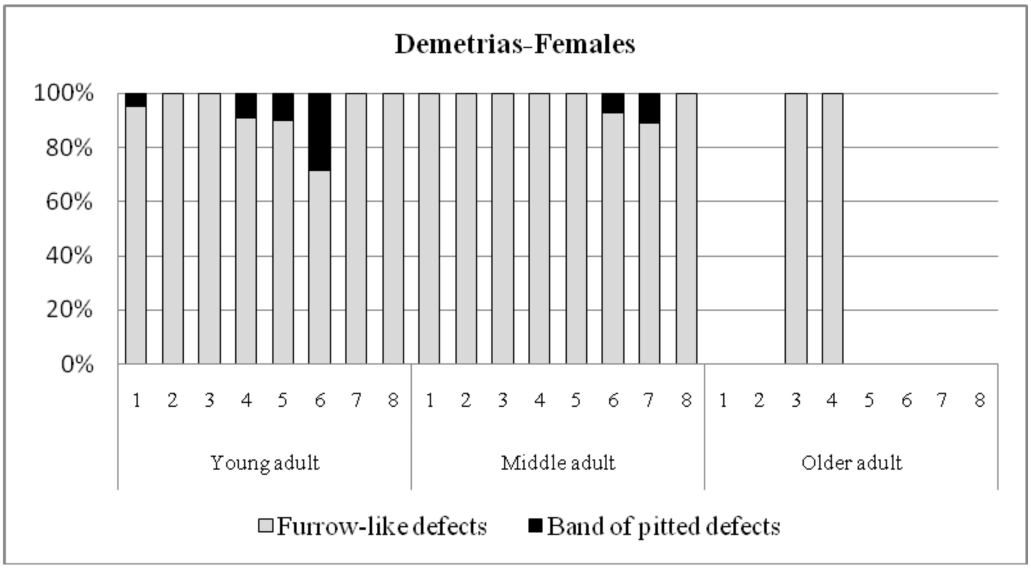

Figure 5.53: Frequency rates of tooth regions with furrow-like and band of pitted defects of enamel for each tooth type (upper and lower dentition together), by age group, in females from Demetrias.

defects, and 0.8% by bands of pitted defects; no plane-form defects were observed (Fig. 5.53). Furrow-like defects rates increased from young (19.3%) to middle adults (31.0%) and significantly decreased to 5.9% in older individuals (Fig. 5.53). For pit defects, the frequencies were 1.3%, 0.4% and 0.0% for young, middle and older individuals, respectively (Fig. 5.53).

Furrow-like and pit defects were observed in 0.0% and 0.2% of the occlusal, 30.0% and 1.1% of the contact, and 33.7% and 0.7% of the cervical areas of the sample, respectively. The most frequently affected tooth types (upper and lower together) for the occlusal, contact and cervical regions were first molars (1.6%) for pit defects (PD) (furrow defects not observed in the occlusal area), first incisors (52.2%) for furrow-like defects (FD) and second premolars (2.9%) for PD, and first incisors (50.2%) for FD and second premolars (1.8%) for PD, respectively. Furrow-like defects affected the lower (21.6%) dentition more frequently the upper (20.8%), whereas the opposite was the case for pit defects (1.0% and 0.7% for maxillary and mandibular teeth, respectively).

5.4.2.1.2 Males

In the whole male assemblage from Demetrias, a total number of 797 teeth and 66 individuals were examined for the presence of DDE; 255 (32.0%) teeth and 39 (59.1%) individuals were affected. The overall (regardless of defect type and tooth region) DDE frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were 40.7%, 34.0% and 16.0%, respectively.

The most frequently affected tooth region was the contact area (30.7%), followed by the cervical area (29.7%) and the occlusal region (0.2%). In total, 20.7% of the areas (cervical, contact and occlusal) observed, were affected by furrow-like defects, and 0.7% by bands of pitted defects; no plane-form defects were observed (Fig. 5.54). Furrow-like defects rates decreased from young (24.3%) to middle (22.0%) and older (12.6%) individuals (Fig. 5.54). For pit defects, the frequencies were 0.9%, 0.8% and 0.0% for young, middle and older individuals, respectively (Fig. 5.54).

Furrow-like and pit defects were observed in 0.0% and 0.2% of the occlusal, 30.0% and 0.8% of the contact, and 28.8% and 0.9% of the cervical areas of the sample, respectively. The most frequently affected tooth types (upper and lower together) for the occlusal, contact and cervical regions were canines (0.4%) for PD (furrow defects not observed in the occlusal area), canines (56.9%) for FD and

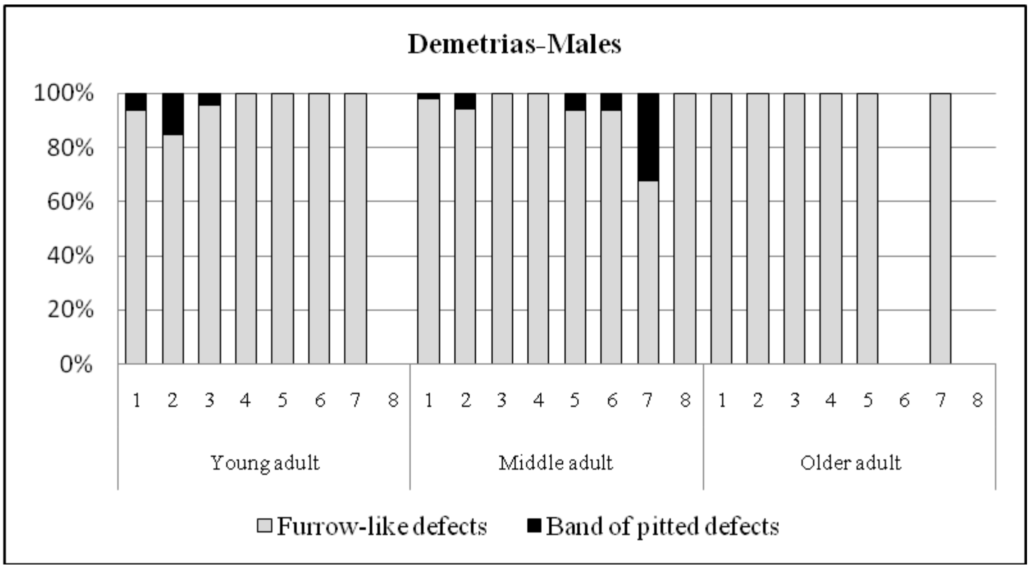

Figure 5.54: Frequency rates of tooth regions with furrow-like and band of pitted defects of enamel for each tooth type (upper and lower dentition together), by age group, in males from Demetrias.

second incisors (3.4%) for PD, and canines (56.3%) for FD and second incisors (2.5%) for PD, respectively. Furrow-like defects affected the lower (21.6%) dentition more frequently the upper (19.6%), whereas the opposite was the case for pit defects (0.8% and 0.6% for maxillary and mandibular teeth, respectively).

5.4.2.2 Athens

5.4.2.2.1 Females

In the whole female assemblage from Athens, a total number of 386 teeth and 49 individuals were examined for the presence of DDE; 67 (17.4%) teeth and 17 (34.7%) individuals were affected. The overall (regardless of defect type and tooth region) DDE frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were 8.5%, 23.0% and 17.1%, respectively.

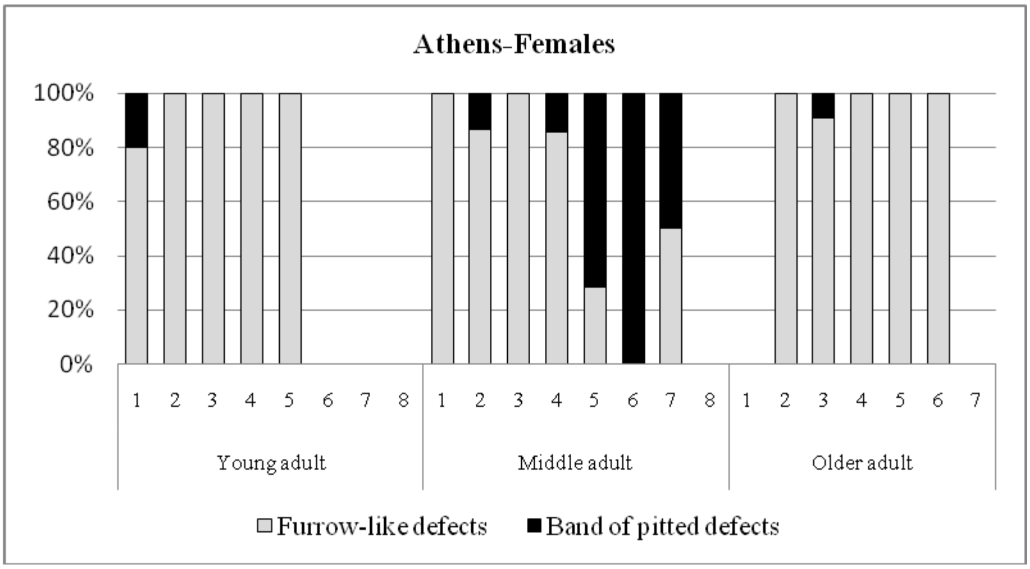

Figure 5.55: Frequency rates of tooth regions with furrow-like and band of pitted defects of enamel for each tooth type (upper and lower dentition together), by age group, in females from Athens.

The most frequently affected tooth region was the cervical area (16.0%), followed by the contact area (15.3%) and the occlusal region (1.1%). In total, 9.5% of the areas (cervical, contact and occlusal) observed, were affected by furrow-like defects, and 1.3% by bands of pitted defects; no plane-form defects were observed (Fig. 5.55). Furrow-like defects rates increased from young (5.0%) to middle adults (12.2%) and decreased to 10.0% in older individuals (Fig. 5.55). For pit defects, the frequencies were 0.3%, 2.4% and 0.4% for young, middle and older individuals, respectively (Fig. 5.55).

Furrow-like and pit defects were observed in 0.0% and 1.1% of the occlusal, 13.7% and 1.6% of the contact, and 14.7% and 1.3% of the cervical areas of the sample, respectively. The most frequently affected tooth types (upper and lower together) for the occlusal, contact and cervical regions were first premolars (2.5%) for PD, canines (30.8%) for FD and second premolars (8.3%) for PD, and canines (32.3%) for FD and second premolars (5.3%) for PD, respectively. Furrow-like defects affected the lower (14.7%) dentition more frequently the upper (3.5%), whereas the opposite was the case for pit defects (1.5% and 1.2% for maxillary and mandibular teeth, respectively).

5.4.2.2.2 Males

In the whole male assemblage from Athens, a total number of 508 teeth and 57 individuals were examined for the presence of DDE; 129 (25.4%) teeth and 30 (52.6%) individuals were affected. The overall (regardless of defect type and tooth region) DDE frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were 25.8%, 18.5% and 43.2%, respectively.

The most frequently affected tooth region was the cervical area (24.6%), followed by the contact area (22.2%) and the occlusal region (0.7%). In total, 17.3% of the areas (cervical, contact and occlusal) observed, were affected by furrow-like defects, and 0.5% by bands of pitted defects; no plane-form defects were observed (Fig. 5.56). Furrow-like defects rates decreased from young (19.7%) to middle adults (10.2%) and rose to 29.7% in older individuals (Fig. 5.56). For pit defects, the frequencies were 0.1%, 1.0% and 0.5% for young, middle and older individuals, respectively (Fig. 5.56).

Furrow-like and pit defects were observed in 0.0% and 0.7% of the occlusal, 21.6% and 0.6% of the contact, and 23.6% and 1.0% of the cervical areas of the sample, respectively. The most frequently affected tooth types (upper and lower together) for the occlusal, contact and cervical regions were first incisors (2.2%)

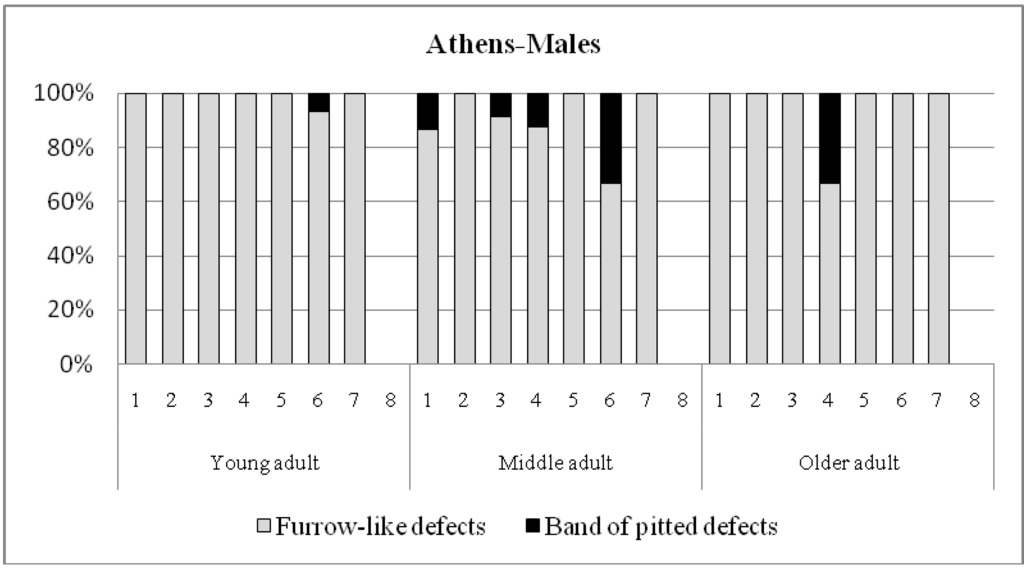

Figure 5.56: Frequency rates of tooth regions with furrow-like and band of pitted defects of enamel for each tooth type (upper and lower dentition together), by age group, in males from Athens.

for PD, first incisors (45.1%) for FD and first premolars and molars (1.6%) for PD, and first incisors (45.3%) for both FD and PD (3.8%), respectively. Furrow-like defects affected the lower (22.1%) dentition more frequently the upper (11.0%), whereas the opposite was the case for pit defects (0.8% and 0.3% for maxillary and mandibular teeth, respectively).

5.4.3 Within socioeconomic status (SES) groups

5.4.3.1 Demetrias

5.4.3.1.1 Low SES

In the whole low SES sample from Demetrias, a total number of 453 teeth and 40 individuals were examined for the presence of DDE; 254 (56.1%) teeth and 31 (77.5%) individuals were affected. The overall (regardless of defect type and tooth region) DDE frequencies (number of teeth affected out of teeth present and

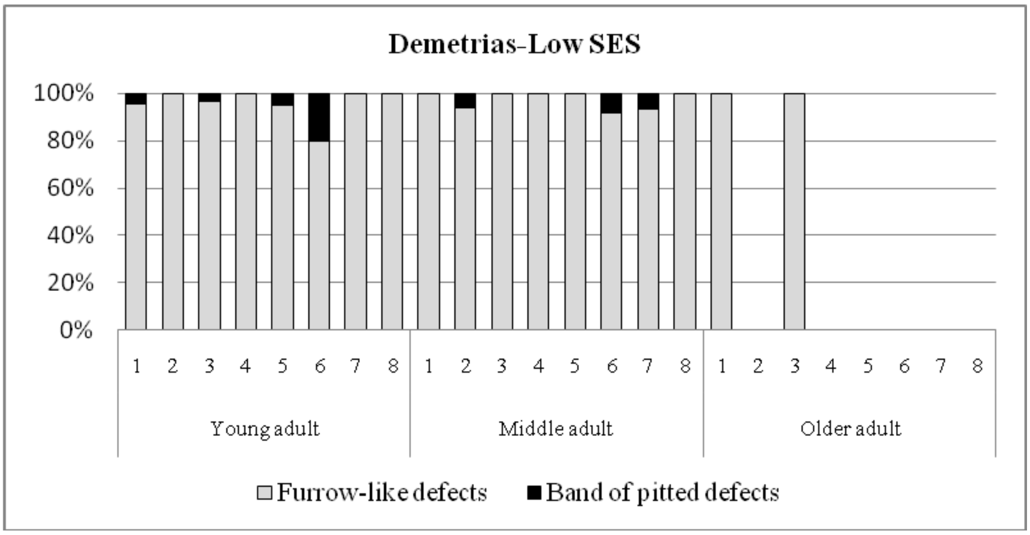

Figure 5.57: Frequency rates of tooth regions with furrow-like and band of pitted defects of enamel for each tooth type (upper and lower dentition together), by age group, in the low SES group from Demetrias.

observable) for young, middle and older adults were 56.8%, 56.0% and 42.9%, respectively.

The most frequently affected tooth region was the cervical area (55.8%), followed by the contact area (54.9%) and the occlusal region (0.2%). In total, 37.4% of the areas (cervical, contact and occlusal) observed, were affected by furrow-like defects, and 0.9% by bands of pitted defects; no plane-form defects were observed (Fig. 5.57). Furrow-like defects rates slightly increased from young (37.1%) to middle adults (37.8%) and decreased to 28.6% in older individuals (Fig. 5.57). For pit defects, the frequencies were 1.6%, 0.7% and 0.0% for young, middle and older individuals, respectively (Fig. 5.57).

Furrow-like and pit defects were observed in 0.0% and 0.2% of the occlusal, 54.4% and 0.4% of the contact, and 54.2% and 1.5% of the cervical areas of the sample, respectively. The most frequently affected tooth types (upper and lower together) for the occlusal, contact and cervical regions were first molars (1.9%) for PD, canines (82.4%) for FD and second incisors (2.0%) for PD, and canines (81.3%) for FD and second incisors (4.1%) for PD, respectively. Both furrow-like and pit defects affected the upper (39.2% and 1.3%, respectively) dentition more frequently the lower (36.0% and 0.6%, respectively).

5.4.3.1.2 High SES

In the whole high SES sample from Demetrias, a total number of 808 teeth and 63 individuals were examined for the presence of DDE; 161 (19.9%) teeth and 25 (39.7%) individuals were affected. The overall (regardless of defect type and tooth region) DDE frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were 25.4%, 20.1% and 12.8%, respectively.

The most frequently affected tooth region was the cervical area (17.5%), followed by the contact area (17.1%) and the occlusal region (0.2%). In total, 11.7% of the areas (cervical, contact and occlusal) observed, were affected by furrow-like defects, and 0.6% by bands of pitted defects; no plane-form defects were observed (Fig. 5.58). Furrow-like defects rates decreased from young (13.2%) to middle (11.6%) and older (9.9%) individuals (Fig. 5.58). For pit defects, the frequencies were 0.9%, 0.8% and 0.0% for young, middle and older individuals, respectively (Fig. 5.58).

Furrow-like and pit defects were observed in 0.0% and 0.2% of the occlusal, 15.9% and 1.1% of the contact, and 17.2% and 0.4% of the cervical areas of the

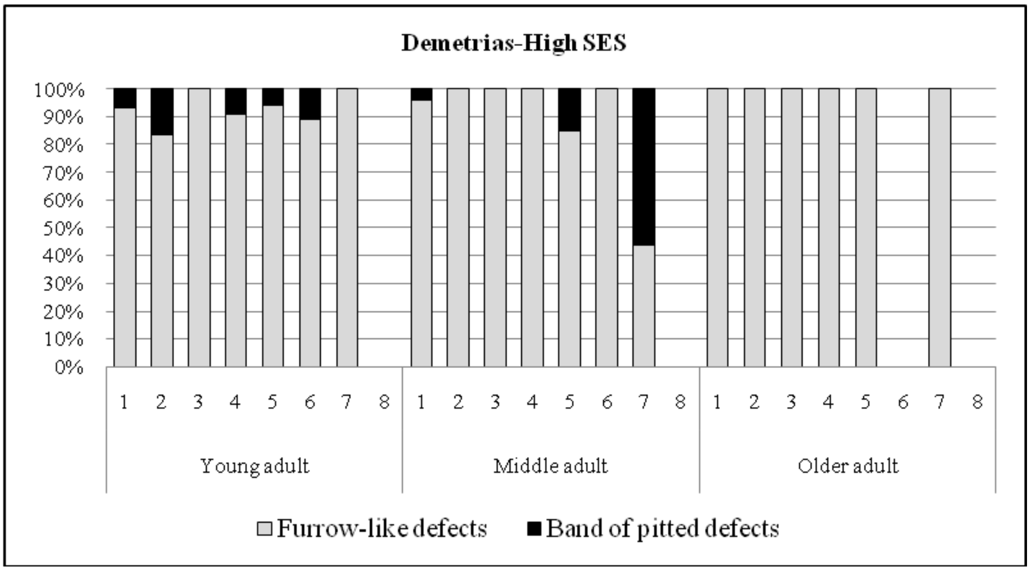

Figure 5.58: Frequency rates of tooth regions with furrow-like and band of pitted defects of enamel for each tooth type (upper and lower dentition together), by age group, in the high SES group from Demetrias.

sample, respectively. The most frequently affected tooth types (upper and lower together) for the occlusal, contact and cervical regions were canines (1.0%) for PD, canines (31.1%) for FD and second premolars (2.9%) for PD, and canines (33.0%) for FD and second molars (1.9%) for PD, respectively. Both furrow-like and pit defects affected the lower (13.6% and 0.7%, respectively) dentition more often than the upper (9.1% and 0.6%, respectively).

5.4.3.2 Athens

5.4.3.2.1 Low SES

In the whole low SES sample from Athens, a total number of 188 teeth and 17 individuals were examined for the presence of DDE; 51 (27.1%) teeth and 11 (64.7%) individuals were affected. The overall (regardless of defect type and tooth region) DDE frequencies (number of teeth affected out of teeth present and

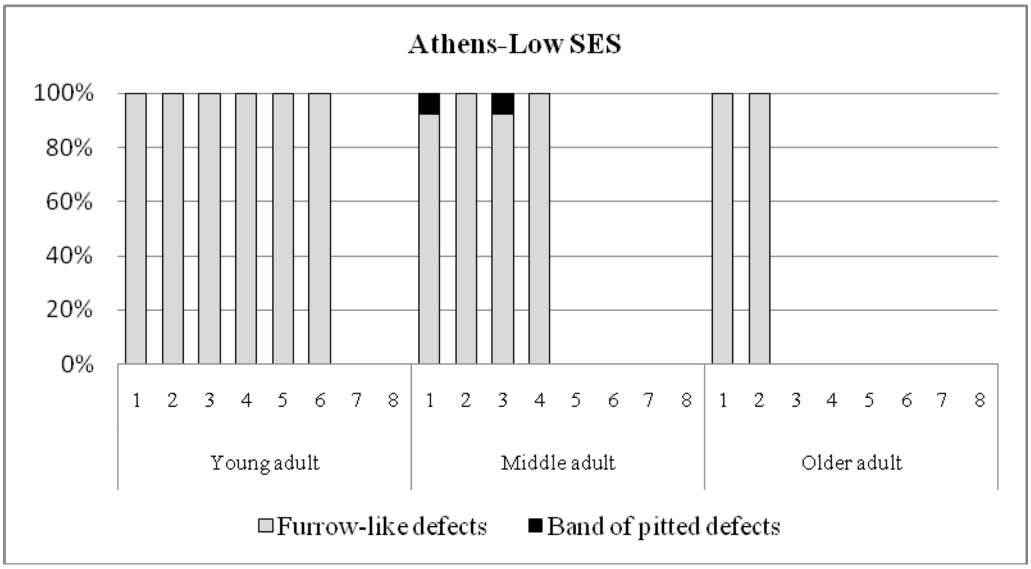

Figure 5.59: Frequency rates of tooth regions with furrow-like and band of pitted defects of enamel for each tooth type (upper and lower dentition together), by age group, in the low SES group from Athens.

observable) for young, middle and older adults were 23.0%, 32.3% and 40.0%, respectively.

The most frequently affected tooth region was the cervical area (26.7%), followed by the contact area (23.0%) and the occlusal region (0.0%). In total, 19.7% of the areas (cervical, contact and occlusal) observed, were affected by furrow-like defects, and 0.4% by bands of pitted defects; no plane-form defects were observed (Fig. 5.59). Furrow-like defects rates increased from young (18.0%) to middle (19.5%) and older (40.0%) individuals (Fig. 5.59). For pit defects, the frequencies were 0.0%, 1.0% and 0.0% for young, middle and older individuals, respectively (Fig. 5.59).

Furrow-like and pit defects were observed in 0.0% and 0.0% of the occlusal, 22.5% and 0.6% of the contact, and 26.2% and 0.5% of the cervical areas of the sample, respectively. The most frequently affected tooth types (upper and lower together) for the contact and cervical regions were first incisors (61.9%) for FD and canines (4.2%) for PD, and first incisors for both FD (65.2%) and PD (4.3%), respectively. Furrow-like defects affected the lower (24.1%) dentition more frequently the upper (13.3%), whereas the opposite was the case for pit defects (0.9% and 0.0% for maxillary and mandibular teeth, respectively).

5.4.3.2.2 High SES

In the whole high SES sample from Athens, a total number of 124 teeth and 16 individuals were examined for the presence of DDE; 35 (28.2%) teeth and 8 (50.0%) individuals were affected. The overall (regardless of defect type and tooth region) DDE frequencies (number of teeth affected out of teeth present and observable) for young, middle and older adults were 0.0%, 21.3% and 41.3%, respectively.

The most frequently affected tooth region was the contact area (28.3%), followed by the cervical area (28.2%) and the occlusal region (0.0%). In total, 17.7% of the areas (cervical, contact and occlusal) observed, were affected by furrow-like defects, and 0.8% by bands of pitted defects; no plane-form defects were observed (Fig. 5.60). Furrow-like defects rates significantly increased from young (0.0%) to middle (12.4%) and older (17.7%) individuals (Fig. 5.60). For pit defects, the frequencies were 0.0%, 1.3% and 0.0% for young, middle and older individuals, respectively (Fig. 5.60).

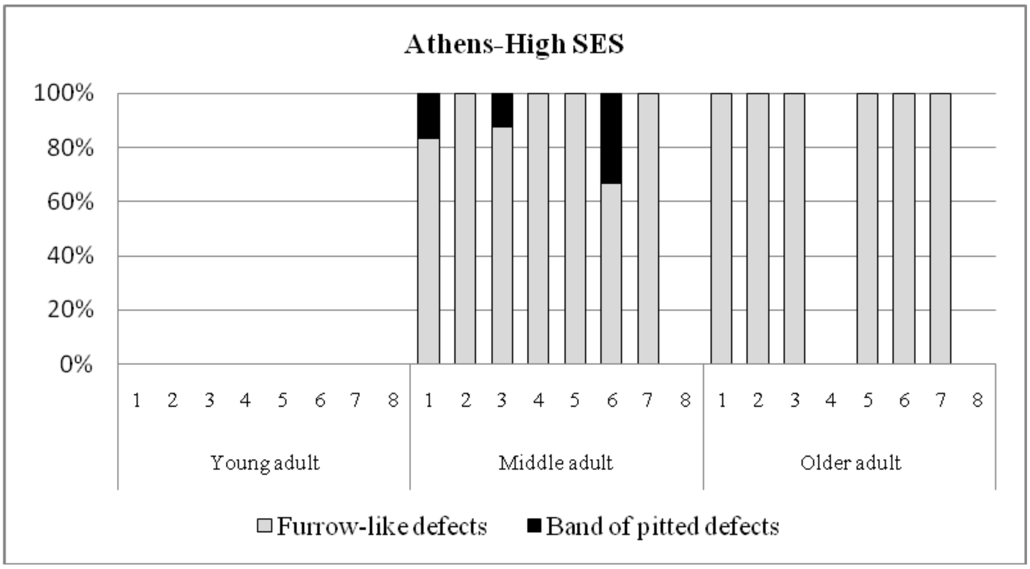

Figure 5.60: Frequency rates of tooth regions with furrow-like and band of pitted defects of enamel for each tooth type (upper and lower dentition together), by age group, in the high SES group from Athens.

Furrow-like and pit defects were observed in 0.0% and 0.0% of the occlusal, 28.3% and 0.0% of the contact, and 25.8% and 2.4% of the cervical areas of the sample, respectively. The most frequently affected tooth types (upper and lower together) for the contact and cervical regions were first incisors (43.8%) for FD, and first incisors (37.5%) for FD and first molars (7.1%) for PD, respectively. Furrow-like defects affected the lower (20.4%) dentition more frequently the upper (13.6%), whereas the opposite was the case for pit defects (1.4% and 0.4% for maxillary and mandibular teeth, respectively).

Chapter 6

DISCUSSION

The present chapter offers a critical discussion of the findings of this thesis, considering both the biological and the social factors that may have contributed to the differences and similarities between the two populations, the sexes and the socioeconomic status groups. An attempt is made to interpret the patterns observed by focusing on and exploring the archaeological, historical and literary evidence available, and by integrating the conclusions of other contemporary studies. Evidence on the economy and diet, the social position of women and female children, as well as on food distribution among the social classes, discussed in *Chapter 2*, are also taken into account and evaluated.

With the intention to address the issue of how different certain life aspects were in ancient populations compared to contemporary ones and to test the assumption that socioeconomic conditions influence oral health status patterns, the Demetrias and Athens assemblages are being compared. This is followed by comparisons of patterns and prevalence among sex and social groups in both assemblages, with the purpose of enhancing the knowledge of socioeconomic conditions in Hellenistic societies in Greece and exploring the issue of the influence of social status on oral health status. As noted earlier in the thesis (*Chapter 1*), emphasis is given to the ancient population as very little information exists on Hellenistic populations, in contrast to the 20th century, for which evidence is abundant through other sources. Variation among subgroups in the modern assemblage is also discussed in brief, in order to compare it to the distribution of conditions detected among subsets in the ancient assemblage.

Each one of the conditions is discussed in a separate section but references to possible associations among the dental pathologies and wear are also made where necessary. Each section comprises of a brief reference to the hypotheses

(*Chapter 2*), key findings with regard to the variation between samples and a discussion of the findings. The overall outcome of the testing of hypotheses is presented in the *Conclusions* (*Chapter 7*).

6.1 Dental Caries

6.1.1 Comparison between populations

The assemblage from Athens is expected to exhibit higher overall frequencies of dental caries than the ancient population, predominantly due to the much softer modern diet and the heavier consumption of fermentable carbohydrates, particularly of refined sugar and sugar/starch foods. Although it is assumed that overall caries prevalence will be significantly higher in the 20th century dental assemblage, the difference of root caries between population samples is expected to be much smaller, since pre-industrial populations are characterised by lesions that started in the cemento-enamel junction as roots were exposed by continuous eruption to compensate for heavy wear (Wasterlain *et al*. 2009).

6.1.1.1 Key findings

- The overall difference of caries rates between the ancient and the modern population was very marked. The assemblage from the contemporary cemetery was notably more frequently attacked by caries than the Hellenistic sample, with almost half of the teeth (45.8%) and nine in ten individuals (91.1%) affected in Athens, as opposed to less than one in ten teeth (8.6%) and half of the individuals (45.4%) affected in Demetrias.
- The AMTL total rate was markedly higher in Athens (52.3%) than Demetrias (7.4%).

- In both populations, the overall frequency of caries, as well as that of AMTL, markedly increased with age.
- A larger proportion of posterior teeth, particularly first molars, was affected by carious lesions and AMTL than anterior teeth, in both assemblages.
- Carious lesions were more common in the upper than the lower dentition in Demetrias but the opposite was the case in Athens, although differences, in both samples, were small.
- First molars were the most frequently affected tooth type and canines the least, in both populations.
- Overall, regardless of age, enamel, dentine and pulp lesions were much more common in Athens. When age groups were considered separately, Athens' rates were higher, except for pulp exposing lesions in older individuals, which were more common in Demetrias. This exception however, is due to the fact that a very large proportion of teeth in this age group were filled or lost antemortem.
- The pattern of distribution within age groups was completely different between the two populations. In Demetrias, all types of lesions were more frequent in older adults and only pulp lesions steadily increased with age, whereas dentine and enamel lesions were more common in the younger than the middle adult age group. In Athens, only pulp lesions were more common in older individuals, dentine lesions rates decreased with age, enamel lesions mostly affected younger adults and fillings frequency was higher in the middle adults, followed by older individuals.
- In both populations, pulp and dentine lesions were predominant in the posterior teeth, whereas lesions confined to the enamel were more frequent in the anterior teeth.

- Occlusal attrition facets in Demetrias and pit sites in Athens were the most commonly affected surfaces, whereas smooth surfaces in the ancient assemblage and root surfaces in the modern sample were the least frequently attacked.

- When occlusal crown sites (i.e. occlusal surfaces, pit sites and occlusal attrition facets) and mesial / distal and buccal / lingual side sites (i.e. mesial / distal contact sites, buccal / lingual smooth surfaces, and mesial / distal, buccal / lingual root surfaces) were compared, the former were the most common sites of carious lesions, in both populations. This difference was more marked in the modern population.

- Carious lesion rates were markedly higher in the modern than the archaeological population, in all tooth surfaces. The biggest difference was observed in pit (46.9% in Athens and 4.1% in Demetrias) and occlusal surface caries (43.9% in Athens and 4.2% in Demetrias) and the smallest in smooth (15.1% in Athens and 2.5% in Demetrias) and root surface caries (9.0% in Athens and 3.5% in Demetrias).

- The distribution of caries between anterior and posterior teeth and the upper and lower dentition was very similar in the two populations. Carious lesions on the occlusal surfaces, pit sites, occlusal attrition facets, contact areas, and root surfaces were more frequent in the posterior teeth in both populations. Smooth surface caries predominated in the posterior teeth of the modern population but in the anterior teeth of the archaeological assemblage. Lesions on the occlusal surfaces, pit sites, smooth and root surfaces attcaked the lower dentition more frequently, whereas caries on the occlusal attrition facets and contact areas were more common in the upper dentition, in both populations.

- Occlusal attrition facet, smooth and root surface caries rates increased markedly with age, in both the ancient and the modern population. The same strong trend with age was observed in the occlusal surfaces and contact areas of the Demetrias sample. The frequency of pit caries in both assemblages, and occlusal caries in Athens only, increased from the young to the middle adult age group but decreased in older individuals. Contact caries rates in Athens were commonest in the older age group, but young individuals were more frequently affected than middle adults.

6.1.1.2 Discussion

In summary, the modern population exhibited a markedly higher overall (regardless of sex, age, SES, tooth and lesion type) frequency of dental caries and AMTL, both in terms of teeth and individuals affected. The distribution of lesions in the dentition, that is between anterior and posterior teeth, upper and lower dentition, among tooth types and classes, was very similar between the two populations. This similarity in the caries pattern in the dentition may be due to factors that are common in all populations, regardless of their diet; namely, the eruption sequence, the position of teeth in the mouth relative to the salivary gland ducts, the traps for plaque made by fissures and pits in the crown, and the cleaning effects of the lips, cheeks, and tongue (Hillson 2008, 120).

In general, the distribution of caries and AMTL among the age groups is also rather similar between the two assemblages, although they come from very contrasting backgrounds and are chronologically distant. Studies on both archaeological and modern populations have shown that caries rates increase and carious lesions become larger with increasing age (Broadbent et al. 2006; Fujita 2009).

The age distribution of the population samples under study indicates that the 20th century people reached an older age than the Demetrias people. Age estimation from the skeleton, however, is problematic as it cannot provide a precise estimation of average age-at-death. Figure 6.1 shows the percentages (%) of (observed) teeth that fall into each age category within each site, rather than the percentage of individuals present in each sample, since age is a demographic parameter that greatly influences caries occurence. Bearing in mind that, in the modern assemblage, there was a large number of teeth lost antemortem and filled, especially in the older age group, it can be suggested that

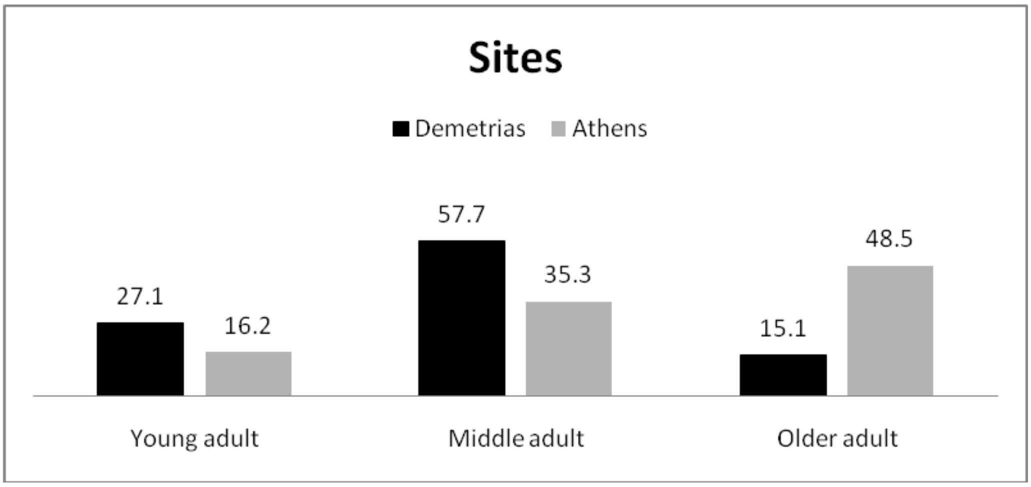

Figure 6.1: Percentage of teeth in each age category in Demetrias and Athens.

the difference in the percentage of observable teeth would have been even greater, had these teeth been observable. The percentages in the chart indicate that, within the assemblage from Demetrias, more than half of the observable teeth fall into the middle-adult age-category, whereas, in the Athens sample, almost half of the teeth fall into the older-adult age-category. This difference in age ditribution might result in misleading overall rates for the modern assemblage. However, all lesion types, i.e. enamel, dentine, and pulp, were more common in the modern population, in all age groups. The only exception was pulp lesions in the older age group, but this is the case only because a very large proportion of teeth in this age class was filled or lost antemortem.

Carious lesion rates were markedly higher in the modern than the archaeological population, in all tooth surfaces. This difference was found to be highly significant statistically, for caries occurrence regardless of lesion severity (χ^2 =894.538, χ^2 =0.000), for enamel, dentine and pulp lesions (χ^2 =1160.020 p=0.000), for cavitated lesions (χ^2 =76.386 p=0.000) and for gross cavities (χ^2=11.670 p=0.001). The difference in crown (especially in pit and occlusal surfaces) lesion rates was extremely large, and it would have been even greater if a significant number of teeth had not been filled or lost antemortem, whereas the difference in the frequency of root surface lesions was relatively small. This is possibly associated with the observation that sites of lesion occurence strongly contrast between archaeological collections and modern populations. In the latter, caries primarily affect the crowns starting early, with newly erupted teeth in childhood, with adults accumulating more crown lesions and adding root caries as the root surfaces are exposed by periodontitis. By contrast, pre-industrial populations tend to be characterised by lesions that started in the cemento-enamel junction as roots were exposed by continuous eruption to compensate for heavy wear (Wasterlain *et al*. 2009, 2). That is not to say that root caries was more common than crown caries in archaeological assemblages. Thus, and although lesions of the crown were more common than root lesions in both populations, in the ancient, root caries rates were relatively high compared to the overall (crown and root) caries frequencies, whereas, in the modern, root caries rates were relatively low, compared to the overall (crown and root) caries frequency. In consequence, the difference between dental assemblages is larger for crown caries and smaller for root caries.

The variation in the frequency and severity of the condition is striking, still not surprising or unexpected for several reasons, namely, light dental wear and, most importantly, high consumption of refined sugar and factory-processed foods in modern populations. In pre-industrial societies, human dentitions have been characterised by a much more rapid rate of wear than the dentitions of contemporary populations (Johansson *et al.* 1993; Seligman *et al.* 1988) and pre-industrial, agricultural populations. And, although caries has a multifactorial aetiology, the amount and type of carbohydrate, especially sugar, in the diet, as well as the frequency of carbohydrate consumption during the day, are of prime importance. This idea is supported by the fact that several studies, both in pre-industrial and industrial samples (Esclassan 2009; Keenleyside 2008; Scott *et al.* 1991; Teaford & Lytle 1996), have shown that caries-rate differences between past and present populations are very marked, with the latter exhibiting much higher lesion frequencies. This suggests that, when ancient and modern populations are compared, diet and secondarily, light occlusal wear, prevail over other factors, such as professional dental care, better personal oral hygiene, water fluoridation, and a diet more dependent on animal protein relatively to the past, in modern populations.

Carbohydrates formed the basis of the diet of both Hellenistic and 20th century Greeks; and both of these populations relied on a staple diet of cereals, legumes, olive oil, and wine for their subsistence (Grivetti 2001). However, diets containing refined sugars are more cariogenic than those consisting of unferined carbohydrates, whereas diets high in protein and fat and low in carbohydrates are associated with lower caries rates (Keenleyside 2008, 264). The main diet-related differences between the two populations that may have contributed to caries variation are the following: (a) higher consumption of meat, fish, and dairy products by modern Greeks, especially in the second half of the 20th

century (Matalas 2001), as opposed to a quite low consumption in the Hellenistic period (Grivetti 2001), (b) food texture (Keenleyside 2008) (c) different kinds of carbohydrates in each diet (Garnsey 1999; Hillson 2008; Matalas 2001), (d) food technology, i.e. processing and preparation (Curtis 2008), and (d) dietary habits (Llena & Forner 2008) were quite different in the past.

Protein consumption

In the late 19th and the 20th century, meat was, most likely, much more regularly consumed than in the Hellenistic period when meat was scarce. Data for 20th century Greece are of course more detailed, and suggests that meat-protein represented 22-27% of the energy available prior to World War II and in the 1950s, and 33-36% of the energy intake in the 1960's (Matalas 2001). This protein intake from meat and meat products further increased in the following decades, but in a lesser degree than it has increased in the period after World War II (Georgakis 2001). Socioeconomic factors are related to this dietary transition; during the decades after World War II, Greek rural society completed its transition from a subsistence economy to a market economy. The economic and social shift was accompanied by drastic changes in food availability and, consequently, in dietary patterns (Matalas 2001).

In antiquity, on the other hand, meat was considered a high-status food because animals were more expensive to raise than cereals and plants. Animals were often used for other purposes than slaughter, for milk, wool, and from the ox, labour. When they were killed for food, it was normally through the sacrificial process. That is not to say that poorer people did not have access to meat but that the majority of the population consumed meat rarely and in very small amounts (Dalby 1996; Wilkins 2006).

Furthermore, milk and dairy products, such as yoghurt, cheese, and butter, constitute a major part of the modern Greek diet, as they represent 10-15% of the total energy supplied by the diet, and 30-50% of the energy supplied by foods of animal origin (Mantis 2001). And, even though milk, cheese and butter were consumed in antiquity too (Brothwell & Brothwell 1969), it is unlikely that their consumption was as widespread as in the 20th century, particularly in its second half, although this cannot be confirmed.

This difference in protein consumption would normally contribute to a lower lesion frequency in the modern population, if this was the only factor affecting caries prevalence. There are however, other significant differences in the dietary patterns between the two populations and these are discussed below.

<u>Food texture and dental wear</u>

Food texture is a very important factor, which indirectly contributes to the development of carious lesions, because it determines the degree of tooth wear. In past populations, whose diet was based on coarse, abrasive and unrefined food, higher rates of occlusal attrition have been reported (Beckett 1994; Esclassan, 2009; Larsen 1987; Miles 1962). On the contrary, post-industrial populations show a very slow rate of wear (Hillson 2008). It is not very clear why this is so, but the most plausible explanation is that ancient diet was based on coarse, abrasive and unrefined food, whereas modern diet is based on soft and refined foods with no abrasive substances in them (Teafort & Lytle 1996). Grinding stones, for instance, added grit to cereals and, if this was not removed after the milling, would have added abrasives to the mouth; culinary or storage techniques, or consumption of preparations made with uncleaned flour or non-dehusked grain of hulled cereal such as barley would also result in high levels of wear (Esclassan *et al.* 2009, 294). Other factors associated with the variation in the degree of wear between past and modern populations include increased chewing time required due to the consumption of tough foods or to the presence of too much dietary fibre, dental work, and the use of teeth in everyday tasks.

In most studies, the severity of occlusal attrition is inversely-related to the frequency of carious lesions (Albashaireh 2010; Boldsen, 2005; Chattah 2006; Hall et al. 2006; Kieser 2001; McKee 1988; Moore & Corbett 1971; 1973; 1975; Smith 1984), firstly because softer foods are more cariogenic and secondly because unworn occlusal tooth surfaces, especially of molars that are markedly the most frequently caries-affected tooth class, concentrate more food and retain it for longer than worn surfaces (Powell 1985).

<u>Carbohydrates and glycaemic index</u>

The glycaemic index (GI) is a classification of the glucose-raising potential of carbohydrate foods relative to glucose (Wolever et al. 1991). Research into GI has clearly proven that equal exchanges of carbohydrate do not elicit similar glycaemic responses. As a result, carbohydrates have been classified into simple and complex and the GI of over 400 foods has been determined (Bahando-Singh *et al.* 2006).

"Differences in the availability of starch for amylases in the upper gastrointestinal tract are a major determinant of the metabolic response, suggesting implications for the rate of formation of fermentable maltodextrins in the oral cavity" (Lingstrom *et al.* 2000a). Studies have shown a correlation between plaque pH (under pH 6.5) and GI for different starchy products; the more prominent the pH in plaque, the higher the G.I. in blood (Lingstrom *et al.* 1993). This may be related to the fact that higher GI starches are more readily digested by salivary amylase into sugars, stick to the tooth surfaces more or are more bioavailable to the plaque bacteria, resulting in more rapid rate of acid production (Wolever 2006, 146). Breads, for instance, generally have a high to moderate cariogenic potential (Morchi 1961). White bread though gives much lower plaque pH values than barley bread, while white, sweetened bread gives almost the same pH fall as sucrose (Lingstrom *et al.* 1993; 2000a).

Therefore, and given the fact that the development of carious lesions is the result of changes in the pH environment of dental plaque deposits (Hillson 2008), it is important to consider the different types of carbohydrates, mainly starches, consumed by Hellenistic and modern Greek populations in relation to their GI. Wheat is a cereal that has been consumed since ancient times, in the form of white bread, but, in Hellenistic Greece, it was mainly consumed by the upper social classes rather than the majority of the population that had barley or rye bread instead (Garnsey 1988). On the contrary, today, white bread is affordable for everyone and possibly the most regularly consumed type, although, until the early 20th century all-wheat white bread was considered a high luxury food and was the bread of choice of wealthier Greeks (Matalas 2001). White bread has the highest GI (100) of cereals, whereas barley bread has the lowest one (31). Other high-GI starches, not available in the Hellenistic period, have also been consumed in 20th century Greece, and these include rice (83) and potatoes (135 for baked potatoes) (Katsilambros & Zampelas 2001).

The most important difference in the carbohydrate consumption between Hellenistic and modern Greek populations however, is the consumption, by the latter, of refined sugar in a variety of foods, which is much more cariogenic than any starch (Lingstrom et al. 1989). Most importantly, sucrose is a major component of the modern diet of Western countries (Rugg-Gunn *et al.* 1986a; 1986b; Woodward & Walker 1994). Its consumption far exceeds that of other common dietary sugars (glucose, fructose, lactose), and it appears also to be the most frequently consumed sugar. It should be noted that the level of its consumption became much higher in the second half of the 20th century and again greatly increased after the 1970's (Kromhout *et al.* 1989).

Sucrose can be broken down directly by extracellular bacterial invertases to form glucose and fructose molecules to produce extracellular polysaccharides having a dual function namely to form a structural matrix of dental plaque and a reservoir of substrate for plaque microorganisms (Marsh & Martin 1999). The functional structure of the matrix enables the plaque bacteria to adhere to the enamel surface. Because of these properties, sucrose has been described as the main cause of dental caries (Anderson *et al.* 2009). However, an exact relationship between consumption of sugars and caries remains unclear. Caries and sugar consumption no longer represents a linear relationship, as poor correlations between total sugar consumption and caries prevalence, within communities are now being reported (Harel-Raviv *et al.* 1996).

The rapid rise in dental caries prevalence in the 19th century has been related to the industrial manufacture and wide availability of sugar. On the other hand, when refined sugar became widely available with the advent of the industrial revolution, it did so at the same time as the mass production of white flour, which is high in gluten and enables pastry and baked goods, such as biscuits, to become widely available or made at home (Anderson *et al.* 2009; Bibby 1966).

There are studies that have noted that caries prevalence is more significantly related to baked goods and snacks, rather than to sugar per se (Bibby 1975; Garcia-Closas *et al.* 1997). It has also been suggested that this lack of significant relationships of sugar to dental caries is because it is the frequent use of the white flour-sugar combination in baked goods and snack foods that is the true relationship (Garcia-Closas *et al.* 1997).

Food processing and preparation and glycaemic response

Blood glucose may be affected by other physiological and nutritional factors, which include the digestibility of the starch, interactions of the starch with protein, the amounts and kinds of fat, sugar and fibre, the presence of other constituents, such as molecules that bind starch, and the level and type of the food processing (Bahando-Singh *et al.* 2006, 476; Englyst *et al.* 1996). The latter is entirely relevant to the present topic and possibly the most important of the factors resulting in caries frequency and severity variation between the ancient and the modern population.

Differences in the glycaemic response to carbohydrate meals can be brought about by the method of cooking and processing. A much greater blood glucose response occurs after the consumption of cooked compared with raw starch, and pureed compared with whole foods (Collings et al. 1981). A study by Bahando-Singh *et al.* (2006), for instance, showed that different processing methods used (boiling, roasting, baking and frying) may influence the GI of a particular food. Foods processed by boiling and frying were found to have the lowest GI. Conversely, all the foods processed by roasting or baking elicited the highest GI and resulted in significantly higher increases in postprandial blood glucose responses.

Many foods eaten in Western countries today are prepared under factory processing conditions very different from conventional cooking methods. The food industry has developed a wide range of convenient and novel snack products, which are ready-to-eat or minimize preparation in the home and have increased storage life. This process may affect the digestibility of the starch and consequently the glucose response (Brand *et al.* 1985). These modern methods of food processing affect the rate of starch digestion in foods and subsequent blood glucose profile for foods.

Conditions that are known to increase the digestibility of starches are those that produce obvious hydration of the granules (gelatinization), distinct changes in chemical nature or disruption of the organized granule structure (Booher *et al.* 1951). Such conditions increase the availability of the starch to amylase and are more likely to occur during factory processing because of the higher temperatures and pressures involved. In extrusion puffing or cooking, enough energy and heat must be applied to thoroughly gelatinize or cook the ingredients (Kent 1978). Most snack products are produced by low or high pressure extrusion with or without frying. Instant rice, for instance, is manufactured using the same puffing process.

In contrast, conventional cooking, used in ancient societies, such as boiling, involve less physical disruption and only moderate heat, and are therefore less likely to cause starch damage or complete gelatinization. Studies (Jenkins 1984; O'Dea, Wong 1983) indicate that the rate of digestion and glycaemic index are correlated and that rate of starch digestion is a rate-limiting step for most foods (Brand *et al.* 1985). The more processed a food is, the higher the glycaemic response it will produce (Brand *et al.* 1985). The glycaemic response increases even if the method of processing is quite simple. Thus, apple juice, for instance, results in higher blood glucose response than raw apple (Katsilambros & Zampelas 2001, 230). Ancient processing methods however, such as grain milling, and olive and grape crushing (Curtis 2008), would have produced the lowest possible glycaemic response and certainly, a much lower one than that produced by modern, factory-processed foods.

In conclusion, food processing increases degradation of starch enzymes and is also associated with an oral environment where the plaque produced by these foods becomes more fermentable by oral bacteria (Lingstrom et al., 1989). This, in combination with the fact that food processes in modern societies dramatically differ from those of the past, suggests that variation in the processing and preparation of cariogenic foods greatly contribute to the variation in carious tooth frequencies between the Hellenistic and the modern populations under study (Temple & Larsen 2007).

Dietary habits

Dietary habits may have also contributed to the caries prevalence difference observed between the ancient and the modern population. Eating more than three times per day in modern societies (Lingstrom *et al.* 2000), especially starch/sugar meals or snacks, is considered to be a highly cariogenic habit (Van Houte 2000). The exposure of plaque bacteria to the starch-derived sugars, glucose and maltose, is influenced not only by bioavailability but also by starch consumption frequency and starch retentiveness. Populations that consume primarily "pure" starchy foods with very few sugars, e.g. African peoples (van Palenstein-Helderman et al., 1996), people in New Guinea (Schamschula et al., 1978) or China (Afonsky, 1951), do so only during two or three meals per day. In contrast, populations that consume high-sugar/high-starch diets, e.g. Western populations, do so with an increased consumption frequency extending beyond regular meals. Besides "pure" sugary or starchy foods, such diets contain a wide array of foods consisting of a mixture of sugars and starches in widely varying proportions (Martinsson, 1972; Holm et al., 1975; Ismail, 1986; Rugg-Gunn et al., 1987).

6.1.2 Comparison among the sex and the socioeconomic status groups

The general hypothesis was that status differences will be reflected in differences between the sexes in both assemblages, because in both Hellenistic and 20th century societies, women were considered socially "inferior" to men. In contrast, it was assumed that no pronounced differences between socioeconomic status groups will be revealed, as differential mortuary behaviour is thought to have reflected individual choice rather that social status in life and occupation is not considered a "strong" status indicator. Comparing the sexes, the levels of caries are expected to be higher in the females of both populations mainly due to the biological tendency of females to have a more cariogenic oral environment due to hormonal fluctuations, the higher consumption of meat by males, and the earlier eruption of female teeth.

6.1.2.1 Demetrias

6.1.2.1.1 Key findings

<u>Between sexes</u>

- The proportion of teeth attacked by caries was slightly larger for females (8.8% for females and 8.5% for males) but more male individuals were affected by the condition (41,7% for females and 48.1% for males). Moreover, when only cavitated lesions were considered, more male teeth and individuals were affected. Additionally, more males had gross cavities and more than one decayed tooth.

- When age groups were considered separately, female teeth were more frequently attacked by caries in all three of them. The same was the case for AMTL but for the first two age groups only.

- Posterior teeth were more often involved (caries and AMTL) than anterior teeth in both sexes. Upper dentition lesions were more frequent in females, whereas lower dentition caries rates were slightly higher for males.

- Overall, regardless of age, dentine and enamel rates were higher in females, but pulp exposing lesions were more common in male individuals. When age groups were considered separately, dentine and enamel caries frequencies were higher for females in all age groups. Pulp lesions more frequently attacked females of the young age class only and males of the middle and older age classes.

- The pattern of distribution of lesions within age groups was very similar between the sexes. Dentine lesions were the most common and enamel lesions the least common type for both females and males in all age groups. Enamel lesions were rare in all age classes, pulp exposing lesions steadily increased with age and dentine lesions showed a large increase in the older adults. When distribution within the dentition was considered, pulp and dentine caries was more frequent in posterior teeth, whereas enamel caries predominated in the anterior teeth. The only differences were that in females, both pulp and dentine lesions predominated in the upper dentition and enamel in the lower, whereas in males, dentine lesions were more common in mandibular teeth.

- Occlusal crown sites were more frequently affected than side sites of the crown and the root, in both sexes. The most commonly attacked sites of carious lesions were occlusal attrition facets for females and pit sites for males, whereas the least affected were smooth surfaces for both sexes.
- Occlusal surface, pit and contact caries affected males more than females, whereas, occlusal attrition facets and root caries attacked females more than males. Smooth surface caries equally affected the two sexes. The biggest difference was observed in contact caries and the smallest in occlusal surface caries.
- The distribution of caries between anterior and posterior, and the upper and lower dentition, was very similar between the sexes. Caries on all tooth sites affected the posterior teeth more than the anterior, with the exception of smooth surface caries in females, which were more common in the anterior teeth. Mandibular teeth were attacked more frequently by lesions on most tooth sites, except occlusal attrition caries in females and contact caries in both sexes, which were more common in the maxillary teeth.
- In most cases, carious lesion rates steadily increased with age. However, in the case of occlusal surface caries in males and root caries in females, the frequency decreased from young to middle and again increased in the older age class; also, pit caries rates in males increased from young to middle but decreased in older individuals.

<u>Between SES groups</u>

- Both the proportion of teeth and the number of individuals attaked by caries were markedly larger for the high SES group. The same was the case, when only cavitated lesions were considered. Additionally, more high SES individuals had gross cavities and more than one decayed tooth.

- When age groups were considered separately, teeth of the high SES group were markedly more often affected by caries in all three of them. AMTL rates were higher for the high SES group in young adults and for the low SES group in middle and older individuals; these differences however, were not marked.

- Posterior teeth were more often involved (caries and AMTL) than anterior teeth and upper than lower, in both SES groups.

- Overall, regardless of age, pulp, dentine and enamel lesions were more common in the high SES group. When age groups were considered separately, again, all types of lesions affected the high SES group more often, in all age classes.

- Some important differences were noted between the two SES groups in the pattern of distribution of lesions within age classes. In the young age class, pulp and dentine lesions were the most common type for the low SES assemblage, whereas for high SES, dentine lesions were the most frequent and pulp the least frequent form. In the two older age groups, pulp lesions were the most common form for low SES and dentine lesions for high SES. Enamel lesions were rare in all age classes and SES groups, except in low SES young adults, and pulp lesions steadily increased with age in both SES groups. Pulp and dentine caries predominated in the posterior and the upper dentition, and enamel in the anterior teeth, of both low and high SES individuals.

- Occlusal crown sites were more frequently affected than side sites of the crown and the root, in both SES samples. The most commonly attacked sites of carious lesions were pit surfaces for low SES and occlusal attrition facets for high SES, whereas the least affected were smooth surfaces for both SES groups.

- Caries affected the high SES sample much more frequently than the low SES, in all the surfaces of the tooth. The biggest difference was observed in occlusal attrition facet caries and the smallest in pit caries.

- The distribution of caries between anterior and posterior teeth was similar in the two SES groups, but important differences were noted in the distribution between the upper and the lower dentition. Caries on all tooth sites affected the posterior teeth more often than the anterior, with the exception of smooth surface caries in the high SES sample, which were more common in anterior teeth, and root caries in the high SES group, which affected anterior and posterior teeth equally. The upper dentition was attacked more frequently by caries in all tooth sites of the low SES assemblage and also, the pit surfaces and occlusal attrition facets of the high SES assemblage. Occlusal, contact, smooth and root caries in the teeth of high SES individuals were more common in the mandibular dentition.

- In most cases, carious lesion rates steadily increased with age. However, in the case of occlusal and pit surface caries in the low SES group and pit surface caries in the high SES group, the frequency increased from young to middle adults but decreased in older individuals.

6.1.2.1.2 Discussion

In the archaeological population, the overall (regardless of age, SES, tooth and lesion type) frequency of carious teeth was slightly higher for female individuals (χ^2=0.070 p=0.791). This was also the case in all three age-groups, whereas AMTL was more commonly observed in young and middle females and older males.

However, more male individuals were attacked by carious lesions. Moreover, when only cavitated lesions were considered, caries was more common both in male individuals and teeth (χ^2=0.630 *p*=0.427). So, on the whole, males were more severely affected by the condition, but females experienced a slightly higher frequency of AMTL (χ^2=25.579 *p*=0.001). Dentine and enamel lesions affected females more frequently than males, overall and also separately in each age-group. Overall rates of pulp lesions, on the other hand, were more common in the teeth of male individuals. When age groups were considered separately, enamel and dentine lesions were more frequently observed in females of all age groups, and pulp lesions, in males of the middle and older age groups and females of the young age group. Occlusal surface, pit and contact caries affected males more than females, whereas, occlusal attrition and root caries attacked females more than males. Smooth surface caries equally affected the two sexes. The relationship between sex and the presence of enamel, dentine and pulp lesions was not found to be statistically significant (χ^2=4.184 *p*=0.242).

With the aim of appreciating the general pattern of sex differences in caries in the present study and avoid AMTL bias, the Lukacs (1992; 1995) method for estimating caries rates more accurately was employed. The use of caries correction factors typically magnifies the inter-sex difference, with male caries remaining essentially the same and female rates displaying a substantial increase (Lukacs 1996; Lukacs & Thompson 2008). In this study, however, the difference between overall caries rates between males and females decreased even more; whereas the uncorrected rates were 8.8% for females and 8.5% for males, the corrected rates increased to 10.9% and 10.8%, respectively, and the difference decreased from 0.3% to 0.1%.

In contrast to other studies of dental caries, which have found markedly higher lesion rates for females (Haugejorden 1996; Keenleyside 2008; Klaus & Tam 2010), males in this study, were more severely affected by the condition. Although the difference between the sexes is not very pronounced, this finding is interesting because females tend to display worse oral health than males, especially in epidemiological surveys in living populations, which consistently report higher mean-age specific scores for decayed, missing, and filled teeth for women than for men (Lukacs and Thompson 2008). Nevertheless, because caries is an age-associated phenomenon, age distribution of each subgoup should be taken into consideration. Figure 6.2a shows that male individuals lived longer than female individuals, and Figure 6.2b, that there are more observable female teeth in the young age group but more male teeth in the middle and older age groups. There is thus a clear age-bias in the two samples, which affects caries distribution between the sexes.

In order not to eliminate but rather to, at least, reduce this bias, the corrected caries rates were estimated for each age-group separately. All the uncorrected rates for females increased from 7.8% for the young, 7.3% for the middle, and 21.1% for the older individuals to 9.0%, 11.1% and 32.0%, respectively. The same was the case for males, with the uncorrected rates rising from 5.5% for the young, 6.8% for the middle, and 20.1% for the older age-group, to 6.0%, 10.0%, and 36.0%, respectively. Thus, whereas the uncorrected rates showed that female teeth were more commonly affected in all age groups, the corrected rates showed that female teeth displayed higher frequencies in the first two age groups only, whereas, in the third age group, males exhibited a considerably higher frequency, but this may be due, or, at least, partly due to the higher mean age-at-death of males. In summary, more male individuals exhibited carious lesions and also, a higher frequency of male teeth was more severely affected. It seems though that the male group had a smaller average number of carious lesions per mouth than females.

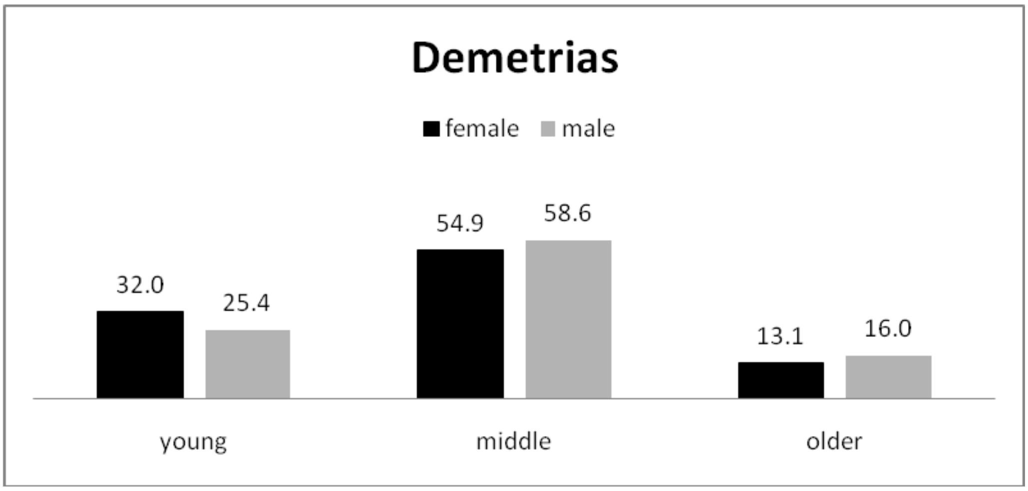

Figure 6.2a: Age distribution of female and male individuals within the Demetrias sample.

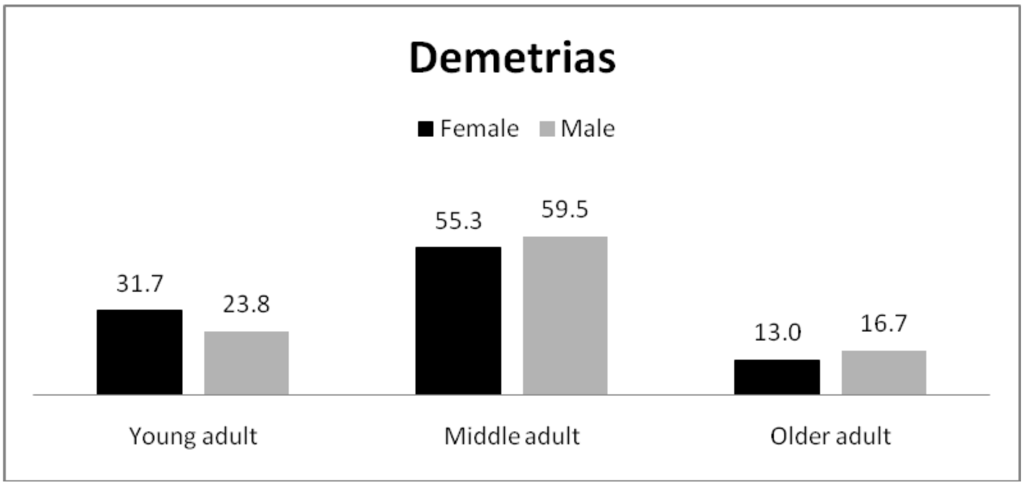

Figure 6.2b: Distribution of female and male teeth among the age groups in Demetrias.

To understand further the relationship between sex and caries, comparisons between females and males within each SES group were made and, thus, an interesting picture emerged. In the low SES group, females displayed higher frequencies of both caries (4.9%) and AMTL (10.6%) than males (3.3% and 5.0% for caries and AMTL, respectively). These differences were both statistically significant (caries: p=0.042, AMTL: χ^2=38.607 p=0.000). On the contrary, in the high SES group, males exhibited higher rates of both caries (14.9%)) (χ^2=1.763 p=0.104) and AMTL (9.5%)) (χ^2=40.082 p=0.000) than females (12.7% and 5.2% for caries and AMTL, respectively). When the corrected rates were estimated, the distribution of carious lesions between the sexes did not change. Instead, the differences in both low and upper SES group markedly increased for both sexes; in the former, corrected rates increased to 7.8% for females and 4.2% for males, and in the high SES group, the rates rose to 14.9% for females and 19.3% for males. Additionally, when pulp-exposing lesions were considered separately, the same pattern was observed; low SES females showed higher rates (2.7%) than males (1.9%) (χ^2=9.167 p=0.01), while in the high SES group, males were more frequently affected (5.7%) than females (3.3%)) (χ^2=1.664 p=0.197). In the low SES tooth assemblage, pulp lesions equally affected the sexes in the young age class, but more commonly affected middle and older females than their male counterparts, with the difference in the third age group being very marked (13.3% for females and 0.0% for males). In the high SES group, pulp lesions were more common in females of the young age class but markedly more frequent in males of the middle and older age classes.

Overall caries and AMTL rates were also estimated for each age group, in order to avoid age bias; the results for the high SES group, clearly showed both caries and AMTL rates for males were higher in all age groups. In the low SES, the results were more complex; females suffered lower rates of caries in the first age group but higher in middle and particularly the older groups (2.6%, 5.7% and 13.3% for young, middle and older females and 2.9%, 3.6% and 0.0% for young, middle and older males). But AMTL did not follow the same pattern; females had more teeth lost antemortem in the first two age groups (3.3% and 13.4%) than males (1.3% and 5.8% for young), while, in the older age group, AMTL rates were markedly higher for males (19.1%) than females (8.3%). The corrected rates estimation for low SES, revealed a different picture, with females exhibiting higher lesion frequencies in the young age class as well.

Taken together, the results indicate that in the low SES sample, female individuals suffered both more frequently and more severely than males, whereas for the high SES sample, the reverse appears to be the case, with males displaying both higher caries rates and more severe lesions than females. It should be noted here that males of both SES groups lived longer than women.

According to literary sources, sex differences in diet existed among the ancient Greeks (Garnsey 1999; Keenleyside 2008); men were given preferential access to foods, especially meat and possibly fish (Garnsey 1999). Because of this and the fact that females tend to suffer from dental caries more extensively than males due to biological factors previously (*Chapter 2*) discussed, it was expected that females would exhibit higher caries rates and/or more severe lesions than males. Therefore, the higher rates and degree of severity for female individuals in the low SES sample are an expected research finding, given the fundamental biological relationship between female sexual development, reproductive function, and oral health (Lukacs 2008, 910).

Unfortunately, because of the fact that both the biological tendency of females to have a more cariogenic oral environment, and the lower protein consumption (and eating frequency) by them, have the same outcome of higher caries prevalence, it is impossible to say whether this variation is the result of the biological factors only, or, of a combination of the biological and dietary factors. Thus, whether or not the social parameters affecting differential access to food resources contribute to this variation between the sexes, cannot be answered in this case. The results therefore indicate either that the diet did not differ between the sexes, or that, although it differed, this cannot be inferred from the outcome of this study due to the fact that females tend to suffer more severely by caries.

Consequently, the dental caries results cannot suggest answers regarding diet in cases where the result is higher rates for females. When the opposite of the expected is the case, however, that is, if rates are higher for males (as it is the case for high SES in the present study), then, it can be assumed that some other factors, other than the biological, that are possibly socially induced and diet-related, played a major role in caries distribution within the population. The longer male lifespan could have been an explanation but caries were more frequent in males in all age groups, pulp lesions were much more common in the teeth of both middle and older individuals, and AMTL rates were considerably higher for males, overall and in each age class separately.

As has already been pointed out in *Chapter 2*, males belonged to the advantaged social groups (Fantham 1975), and social differences led to differential access to food resources. However, it is not currently clear which specific foods the socially "advantaged" had access to, and whether there were local differences in the foodstuffs available to them. Although there is evidence to suggest that in Greece as a whole, meat, for instance, was a high-status food because of the cost of its production, but it is not certain whether meat was scarce, or at least, as scarce in Hellenistic Thessaly as in other areas or time-periods. Moreover, access to other foods, in addition to meat, must have been easier for the more advantaged members of the society.

We know from written sources that the status and power of an individual in the household and in society at large, was crucial to food allocation and greatly influenced the foods eaten, their quality, and styles in which they were consumed. There were also instructions of physicians to restrict food consumption and deny wine, meat, and other nourishing foods to women (Garnsey 1999), but this would mean worse dental health for women and therefore does not explain the higher caries rates for males in the Demetrias population. The explanation should, therefore, be sought elsewhere and, despite the fact that there is no clear indication that higher status individuals consumed some particular cariogenic foods, there is some indirect evidence that may at least offer some insight into this issue.

Firstly, however, it is useful to consider the differences found in the caries rates and severity between the low and high SES groups. These, in combination with sex differences, can provide further insight into the possible causes behind these variations. In brief, both the proportion of teeth and the number of individuals attacked by caries were markedly larger for the high SES group and this difference was found to be statistically significant (χ^2=119.168 p=0.000). The same was the case, when only cavitated lesions were considered (χ^2=6.778 p=0.009). Additionally, more high SES individuals had gross cavities and more than one decayed tooth. Corrected caries rates increased the difference between the SES groups; more specifically, in the low SES group, the frequency increased from 3.9% to 5.6%, and, in the high SES group, it rose from 13.9% to 16.9%. When age groups were considered separately, teeth of the high SES group were markedly more often affected by caries in all three of them. AMTL rates were higher for the high SES group in young adults and for the low SES group in middle and older individuals; these differences however, were not marked. Because of the fact that AMTL was higher in the middle and older individuals of the low SES groups, corrected caries rates were also estimated. In the low SES sample, the rates for young and middle adults increased from 2.8% to 3.0% and from 4.5% to 6.7%, respectively, whereas, in the high SES, percentages rose from 10.8% to 11.45% for the young and from 11.5% to 15.6% for the middle adults. The increase in the teeth of older individuals was rather impressive, particularly in the high SES group; in the low SES, the frequency rose from 4.1% to 12.5% and in the high SES group, from 22.1% to 58.7%. Additionally, overall, regardless of age, pulp, dentine and enamel lesions were more common in the high SES group (χ^2=128.845 p=0.000) and this was also the case in each age class separately. Caries affected the high SES sample much more frequently than the low SES, in all the surfaces of the tooth.

Comparisons between low and high SES within each sex group were also made and the results revealed that in both the female (4.9% for low and 12.7% for high SES) and the male (3.3% for low and 14.9% for high SES) sample, high SES teeth were markedly more frequently affected by the condition than low SES teeth. The relationship between caries occurrence, regardless of lesion severity, and SES was highly significant for both female (χ^2=29.359 p=0.000) and male (χ^2=94.626 p=0.000) teeth. The relationship between enamel, dentine and pulp lesions and SES was also highly significant for both sexes (females: χ^2=38.048 p=0.000, males: χ^2=98.903 p=0.000). AMTL in the female sample was more frequent for the low SES (10.6%) than the high SES (5.2%), whereas the reverse was the case for the male sample (5.0% for low SES and 9.5% for high SES).

When correction factor rates were estimated, however, the difference in the female assemblage slightly decreased, whereas the difference in the male sample became more pronounced, with the percentage of male carious teeth rising to 19.3%.

In summary, assessment of the corrected caries rates and caries-induced pulp exposures suggests that the high SES sample suffered both more frequently and more severely than the low SES sample. This was also true when the two SES samples were compared among females and males, separately. As was the case with females and males, low SES individuals were expected to suffer more severely by caries, mainly because of their heavier reliance on carbohydrates and lower intake of protein compared to high SES individuals. The opposite of the expected was found to be the case though. The fact that both males of the high SES group and high SES individuals, regardless of sex and separately within sex, were more severely affected by caries, points to the possibility of a more cariogenic diet for the socially "privileged" groups. This view is enhanced by ancient literary evidence suggesting that the well-off family had an advantage because it had access to a wider range of foodstuffs and that poorer people were more likely to eat products of local agriculture, while the richer were able to supplement their diet with more costly regional products, as well as imports (Garnsey 1999).

Therefore, there were foods that can be defined as "luxury" items. These are regarded status indicators because they were not widely attained, and typically occur in hierarchical societies as a means of distinction. The types of food used to display status and distinction are culturally specific. In simple societies, with no formalized hierarchy, the emphasis is on quantity, especially of meat, and on elaborations of common staple foods. In highly complex societies, the emphasis is on quality; the focus is on expensive, rare and exotic foods (Palmer & van der Veen 2002). Refinements of food may be expressed in terms of texture, for instance, 'white' versus unrefined or 'brown' bread, fresh rather than dried food, succulent versus tough meat, additional flavour (herbs and spices), a higher fat content (meat, dairy products, nuts, etc.) or other qualities, e.g. of wine (van der Veen 2003, 413). The distinction between the emphasis on quantity and cohesion or quality and exclusivity is significant as it reveals the hidden meaning behind consumption events and with it the structure of a society (van der Veen 2003). The conclusion in this case, however, is that SES affected both quality but also quantity of foods and drinks consumed and that both exclusivity and quantity affected caries distribution among social classes.

The daily routine of food consumption reflects and recreates the social and symbolic codes of a society (Bourdieu 1990). In simple societies, day-to-day consumption consists of foods locally produced, with the emphasis on staples and occasional meat. There will be little or no differentiation between households, except that the leader(s) may have access to more or better cuts of meat. Here, luxury foods will be eaten in exceptional circumstances only, usually during feasts. By contrast, in strongly hierarchical societies, day-to-day consumption will be characterized by differences between households, groups of households and types of settlement, and these differences are displayed not during occasional feasts, but on a regular basis, if not every day. Thus, some households will display consumption of food that is different from the rest, in terms of either quantity or quality, and this may include expensive, rare or exotic foods. Here, the consumption of luxury foods is a regular event, though only at certain households (van der Veen 2003, 416).

Written sources suggest that communal feasts, where non-staple foods such as meat, were shared among the participating citizens, were taking place in Greece at this time. However, Hellenistic societies were complex societies, in terms of hierarchy, and a significant part of the population is expected to have displayed not only occasional but also regular consumption of food that was different from that of the rest of the people. There is indirect evidence to support this and the results of the present study also seem to be in accordance with this theory. The difference found in the prevalence and severity of caries between low and high SES groups attests to a regular dietary variation. If the consumption had only been occasional, this would not have been reflected in caries distribution.

The important question that remains to be anwered is which foods in particular could have contributed to a more cariogenic diet for the socio-economically privileged groups, as these are defined by sex, i.e. males, and SES, i.e. individuals of high SES. As previously mentioned, information in this respect is very scarce, especially in this part of Greece and this time-period and thus, only assumptions can be made, based on a mere handful of indirect evidence that may shed some light into this issue. Valuable clues on this subject matter are commonly found in trade and redistribution of foodstuffs, especially in such cases as the Hellenistic empires, which brought together regions with different ecological conditions and products, thus enhancing the possibility of exchange among them. This is mainly because exotic food items are possibly the category of luxury foods most easily identifiable in the archaeological record, and their symbolic value makes any study of their occurrence and differential access highly profitable. The temporal and spatial patterning of their occurrence in any one region will almost certainly reveal luxury consumption, as well as status differences between sites or households. Imported goods can be luxuries in that, even when they are abundant in their place of origin, they are rare at the place of consumption. The costs of transport, together with their limited availability on the market, make these goods especially expensive and therefore accessible to only a part of the population (Ervynck *et al.* 2003).

In the case of the present study, however, although there is strong evidence to suggest that trade of exotic food items was undoubtedly taking place, especially in Hellenistic times, most of the imported foodstuffs could not have contributed to the higher caries rates observed in the high SES individuals. Written sources, as well as archaeological evidence from shipwrecks, indicate that wine, olive oil, spices, and exotic fruits were the most extensively traded items. Olive oil, wine and spices are not cariogenic; moreover, all of these commodities, as well as fruits, though of different kinds, were also regionally available and consumed by everyone, though probably not in equal amounts and all varieties.

One of the few imported foods that could have contributed to the higher caries rates in the high SES group is rice, which was generally little-used in antiquity. It was domesticated in India, Southeast Asia, and China, and seems to have been imported from India, following Alexandrer's conquests. The high costs of long-distance transport would have made rice very expensive; hence its seemingly slight use, which was most likely confined to wealthy households (Alcock 2006, 34-35). Moreover, fruits, such as apricots, cherries and peaches, that were known in the East very early but only became familiar further west after Alexander's expeditions (Dalby 2003, 20), were imported in the Hellenistic period, and were only available to the well-off families (Alcock 2006). Although fruits were consumed by the poor as well, it seems that, at least some of them, were considered luxury items and were probably consumed in larger quantities by the wealthier.

Sugarcane could also have played a part in the greater caries frequency in the high SES individuals. It was noticed by Alexander during his campaign in the Indus Valley in 325 BC. This began an importation of sugar into Greece, where it became in demand as a luxury good (Kretchmer 1991). It was imported in small amounts and it was used in rare cases for therapeutic purposes (Gutsfeld 2010), whereas it is not clear how often it was used as a sweetener. Honey clearly remained the most important sweetener but sugar cane was possibly consumed exclusively by families that could afford its high cost (Gilfillan 1965).

Thus, sugar hardly existed, leaving for sweetening only honey, grape syrup, and the various fruits (Dalby 1996; Waldron 1973). Honey, which was regionally available in many parts of Greece, was a costly product in relatively limited supply and very much desired for its flavouring qualities (Dalby 1996). Although there is evidence to suggest that honey was not exclusively available to the rich, it was clearly not a staple and was therefore not regularly consumed by the poor (Wilkins 2000). On the contrary, drinks made from honey or fruits, honey-cakes, wine or water mixed with honey, plums boiled in honeyed wine, as well as preserved fruits, and grape-syrup, which was made by boiling down unfermented grape-juice and was also used for flavouring wine (Gilfillan 1965, 55), were the distinctive dietary sources for the wealthy (Dalby 1996; Grant 2001).

Studies on the issue of the cariogenicity of sugarcane remain equivocal to the present day (Frencken *et al.* 1989; Singh & Evans 2005; Takata *et al.* 2007). Although sucrose is claimed to be highly cariogenic, there is evidence to suggest that the removal of phosphate from sucrose derived from sugarcane, during the refining process, highly contributes to its cariogenicity (Beck & Bibby 1961).

Some studies show that raw sugarcane (unrefined sugar) has a relatively low cariogenic potential (Singh & Evans 2005). This is undoubtedly the case when the cariogenicity of sugarcane is compared to that of refined sugar (Frencken *et al.* 1989; Rugg-Gunn 1983). Other studies have shown that sugarcane has a caries-promoting effect and, especially when it is regularly consumed, it can be damaging to the teeth (Dreizen & Spies 1952; Frencken *et al.* 1989; Gorman *et al.* 2006). It follows from this fact that, at least theoretically, sugarcane consumption by the high status individuals and non-consumption by the poorer could have been a contributing factor to the higher caries prevalence in the former. However, it is not clear whether imported sugarcane, apart from being used in medicine, was also part of the diet of those who could afford it (Gutsfeld 2010). Futhermore, even if it was, there is no indication that its consumption was regular, though this possibility should not, in any case, be ruled out.

Honey, although it has a less cariogenic effect than other sugars and refined sugar in particular (Bogdanov *et al.* 2008), has nevertheless a high glycaemic index (Jenkins *et al.* 1981) and is highly caries-promoting (Bowen & Lawrence 2005). Especially when sugars are combined with starch, as in the case of honey-cakes, they can be particularly caries-inducive (Garcia-Closas *et al.* 1997). Intrinsic sugars that are naturally present within the cellular structure of foods, such as fruits, have a relatively low cariogenic potential (Riley 2003; Zero 2004) in comparison to extrinsic sugars, such as honey or refined sugar, added to foods (Sheiham 2001). Moreover, dried fruits, which were possibly more frequently consumed by the affluent, appear to be more highly caries-inducive than fresh fruits (Ogata & Trahms 2003).

Therefore, a diet containing abundant fresh and dried fruits, fruit drinks, plums boiled in honeyed wine, honey cakes, grape-syrup, and possibly sugarcane, although less cariogenic than a modern-day diet rich in added sugars, has nevertheless a higher cariogenic potential than a diet that mainly consisted of porridge and bread made from barley, legumes, vegetables and little meat, fish, fruit, and wine (Grivetti 2001; Wilkins & Hill 2006) and was characterised by only occasional consumption of fruits and honey (Pollard 1995). In conclusion, the higher prevalence of caries in the privileged group was possibly the result of more frequent access to foods containing sugars, mainly glucose and fructose, rather than access to specific foods consumed exclusively by the rich. The only exception might have been rice and sugarcane, the high cost of which most probably kept them out of reach of all but the upper classes, although this cannot be confirmed.

Another contributing factor to the higher caries rates in the upper SES group should be sought in the access to and consumption of different starchy foods, more particularly bread, by the affluent. Cereals, despite the fact that they were staple food for all people, marked out the social hierarchy of Greek society (Wilkins & Hill 2006). They held their place at the centre of the diet of both poor and rich, but different kinds of cereals, processing methods, and patterns of consumption existed. An emphasis was being placed on the different kinds of cereals. Barley was considered inferior to wheat, husked grains to naked grains, porridge to bread, and other forms of wheat to that which made the best bread. Thus, a hierarchy among cereal breads emerged, with white bread at the top. The wealthy were able to signal their "superiority" over social and economic inferiors in their consumption of cereals (Garnsey 1999, 19). Not only were there numerous kinds of cereals but in addition, cereal products took a number of different forms, which can be grouped together under headings such as porridge, flat-cakes, and bread (Garnsey 1999, 15). Bread was consumed by all people, but more frequently by the wealthy, who had bakers in their private households, whereas the poor ate cereals mostly in the form of porridge. Food preparation was already a laborious process, and if anything more special than gruel or porridge was required, the list of tasks was much lengthened (Garnsey 1999, 121).

Moreover, the different kinds of bread reflect social divisions. Black, barley bread was the poor people's bread consumed by the majority of Greeks, whereas white, wheat bread was the bread of the wealthy. The expenditure of extra labour-time and money on milling and sieving in order to make white bread, made it a product that was considered to be superior (Wilkins & Hill 2006). Even among the naked wheats, that is grains whose hulls were removed in processing and were consequently more expensive, there was the soft or bread wheat, as well as the hard wheat, probably eaten in the form of flat unleavened cakes cooked in a griddle (Dalby 2003). Soft wheat made the best bread but was not readily available in Greece, since it was grown in wetter climates. It thus had to be imported or specially purchased, and so was sought after the wealthy, whereas ordinary people probably had no access to this high-status wheat (Garnsey 1999, 120). Therefore, the rarity of wheat and the growing taste of bread, especially that made from wheat, gave wheat extra appeal to those who could afford to buy it. The elite preference for wheat was enhanced by the inaccurate judgement of medical men that barley had a lower nutritional value than wheat (Garnsey 1999, 122).

The importance of this variation in the consumption of cereals and bread among social classes lies in the correlation between starches and caries, and more specifically, in the difference in the cariogenic potential of the various types of starches. Studies have shown that starchy foods differ considerably in their effects on the post-prandial blood-glucose and insulin responses, both when eaten alone (Jenkins *et al.* 1988; Jenkins *et al.* 2002; Trout *et al.* 1993) or as a component of a mixed meal (Brillon et al. 2006; Collier *et al.* 1986; Liu *et al.* 2003; Wolever *et al.* 1985).

Given that demineralisation of tooth surface is the result of pH drops, the glycaemic response to different kinds of starches is important (Lingstrom & Birkhed 1998). Thus, bread baked with intact kernels, that is barley bread, give a low GI and small pH falls; in contrast, kernel-based bread, that is wheat bread, results in lower pH values (Lingstrom *et al.* 2000; Pollard 1995). In a study by Lingstrom *et al.* (2000), it was found that, during the first six minutes after consumption of barley bread, there was a rise of plaque pH. It was suggested that this was "most likely due to the intact structure of the barley kernels, causing intensive chewing and thereby increased salivary flow and bicarbonate concentration" (Lingstrom et al. 2000, 79). Furthermore, different physiological effects result from different methods of processing cereal foods; in other words, processing, that is wheat refinement by milling, has a greater glycaemic response as a result, by comparison with breads made from unrefined, whole grains (Jenkins *et al.* 1986; Moore 1983).

Therefore, higher caries rates and severer lesions should be expected for the affluent, who consumed wheat, than for the poorer, who ate barley. Cereals comprised 70-75% of total consumption and this estimate of total food energy might actually be too low in the case of members of the lower classes (Garnsey 1999, 19); considering this, this quality variation in the consumption of cereals among SES groups might have been a major contributing factor in the caries differences observed in the population under discussion.

A much greater blood glycose response and larger pH drops also occur after the consumption of cooked compared to raw food (Collings *et al.* 1981; Edgar 1983). The early Hellenistic period witnessed a major transformation of the diet and food preparation and consumption habits of Greeks, marked by elaborate, specialist cooking, imported foods and foreign cooks, conspicuous consumption by the rich and an explosion of a wide range of technical literature on food and cookery (Garnsey 1999, 74; Wilkins & Hill 1994). However, there is evidence to suggest that the affluent consumed cooked food much more often than the poorer (Gilfillan 1965) for several reasons. One of them was that cooking was time-consuming and, whereas the wealthy employed cooks and bakers, poorer families could not afford slaves and did not have much time to prepare food or space in which to organise the cooking (Wilkins & Hill 2006). The main reason though, was possibly associated with the fact that wood fuel used for cooking was expensive (Gilfillan 1965; Hughes & Thirgood 1982). By the late Classical times, as adundant sources near the centres of consumption disappeared, wood became rarer as a commodity and had to be traded over long distances. The result was a rise in price and "people caught in areas of short supply might well have found that the wood for a supper fire cost as much as the meat in the pot" (Hughes & Thirgood 1982, 69). Thus, more frequent consumption of cooked food by the affluent could have been a socially-associated factor affecting caries distribution between SES groups.

As has previously been discussed, it is evident that prestige foods, that is, those foods that were scarce and expensive, were reserved for people of means and rank. Thus, some foods and drinks were exclusively or more frequently and in greater quantities consumed by members of the well-off families. The important question here is whether there was discrimination based on gender within these well-off families, or whether this was confined to the lower classes. In the low SES part of the population under study, females were more severely affected by caries than males. Since females tend to get more severely affected by the condition due to biological factors, this caries distribution between the sexes possibly means that the diet of males, though different in terms of protein intake, was not more cariogenic than that of females. Alternatively, there might have been some dietary variation, but this was not substantial enough so as to result in greater caries frequencies in males. This was possibly because the lower classes had little or no access to the cariogenic items previously mentioned and, thus, these could not have been unevenly distributed; processed white bread for instance, seems to have been available to the affluent only.

In brief, according to literary sources, men of low SES ate more meat and drank more wine, but, as indicated by the results of this study, did not have a more cariogenic diet than women. In the high SES assemblage on the other hand, caries affected males more severely than females, pointing to a significant dietary variation. Males of the high SES assemblage were the most severely affected of all sub-groups in the Demetrias population and therefore seem to be the most favoured, based on the previously discussed evidence. This seems to be in accordance with the literary sources, which suggest that women were discriminated against not only in the lower, but also in the upper classes.

In strongly hierarchical and status-conscious societies, the wealthy use food as one of a number of ways of signalling their wealth and as the most effective marker of economic and social distinction for the fact that it consumed the greater proportion of family income (Jongman & Decker 1989). In the Greek patriarchical societies in particular, males of lower or upper classes seem to have been favoured over their female counterparts. It should be borne in mind that for evidence on this issue, we are heavily reliant on the treatises of medical writers, who were members of the upper-classes. Thus, we have high-society doctors telling their male, upper-class clients to limit food consumption of females, through systematic supervision and control from childhood to adulthood, and writing about both the quantity and quality of food women were allowed to eat (Garnsey 1999). For instance, the withholding of wine, meat, and other nourishing foods, and the general instruction to restrict food consumption, were common recommendations by physicians (Garnsey 1999, 103).

Furthermore, women, even those of status, were not admitted to banquets and feasts, where a wide variety of luxury foods and drinks were commonly consumed; they were present only in family meals. Considering that these formal meals took place rather frequently for the well-off (Wilkins & Hill 2006, 65-66), the consumption of scarce and expensive items throughout them, could have resulted in a dietary variation between the sexes. Apart from the direct influence that the absence of women in such dinners had in their diet, there is also a symbolic denotation in this favouritism against them, which points out discrimination in relation to food distribution.

Moreover, women that belonged to the upper classes were more confined to the home than their poorer counterparts; that is to say, where women participated in work outside the household, the gap between the sexes in the division of food would probably have been narrower than where women were confined to the home (Garnsey 1999, 112). This might explain both the lack of marked sex-related differences in cariogenicity of the diet of the low SES group, and the dietary variation in the high SES group, ensuing from the results of this study.

Taking into account all the above, it is logical to deduce that males consumed greater quantities of some of the foods and drink items that the upper classes, as a whole, had access to. Thus, although women of high SES were favoured over their low SES counterparts, both female and male, they were nevertheless less privileged than men of the same status. There is no reason to assume that wheat bread was consumed by the male members of the upper classes only, and that female members ate barley bread, specially made for them, instead. It is more likely that wheat and white bread were available to all members of the upper classes, regardless of sex, although we cannot exclude the possibility of greater consumption of white bread by males. The same also applies to cooked food. Wine consumption, according to literary sources, was a man's privilege and a gender marker; women had access to wine only in specific religious occasions (Pamias & Grau 2005). Consequently, sweetened wine, either with honey or syrup, was predominately consumed by males. The same could have been true, at least in terms of consumption in larger quantities by men, of fresh and dried fruits, as well as honey, sugarcane and rice, although there is no direct evidence to support this. In conclusion, few foods were completely monopolised by the high status individuals. They, however, had access to every kind of food, whether standard or prestige, in greater quantity, with greater frequency, and in better quality.

Apart from diet, oral hygiene could have also, to some extent, influenced caries distribution between the sexes. In historical terms, oral hygiene as a means to an end, is a relatively novel concept, which has only attained public recognition during the 20th century, especially in its second half (Loe 2000). However, ancient civilizations, such as the Greek, are known to have practiced oral hygiene and developed tooth powders containing pumice, talcum, coral powder, and alabaster (Triratana *et al.* 2002). Hippocrates, for instance, had developed his own formulation that contained not only abrasives, but also what were thought to be therapeutic substances (Kanner 1928). For example, myrrh or niter was added as an astringent, presumably to promote gingival and oral mucosal health (Pader 1988). Dental extractions and other procedures have been widely practiced (Arnott 1996; Hoffmann-Axthelm 1981) and some researchers suggest that dentistry may have been practiced as a profession from as early as the second millenium BC (McGeorge 1992).

Sex/gender plays an important role in oral hygiene practices. Females generally tend to have a more pronounced preventive oral health behaviour than males, often regardless of age, nationality, living region, and SES (Coda Bertea *et al.* 2007). Furthermore, although there is a positive association between oral hygiene habits and each gender separately, the impact of this behaviour is more remarkable in males (Coda Bertea *et al.* 2007). Based on these facts, it can be assumed that oral hygiene could have also been partly responsible for the severer affliction of males with caries.

In summary, the probable factors contributing to the socially-advantaged (high SES group and males of the high SES individuals) being more severely affected by dental caries is (a) the longer lifespan of the high SES individuals compared with those of low SES, and the high SES males compared with their female counterparts, (b) the either exclusive or more frequent consumption, by the more prosperous, of rice, sugarcane, honey (especially in combination with cakes, wine, and water), and also grape-syrup, and plums boiled in honeyed wine, and preserved as well as fresh fruits, processed cereals (mainly in the form of wheat-bread as opposed to unprocessed barley-bread by the poorer), (c) the consumption of more cooked food by the affluent, and (d) poor oral hygiene practiced by males.

6.1.2.2 Athens

6.1.2.2.1 Key findings

Between sexes

- The proportion of teeth attacked by caries was equal for females and males but a considerably larger number of male individuals was affected by the condition. When only cavitated lesions were considered, the percentage of teeth attacked was slightly higher for females, but again, there was a significantly larger number of male individuals affected. Furthermore, more males had gross cavities and more than one decayed tooth.
- When age groups were considered separately, female teeth were more frequently affected by caries in the middle adult age group only. AMTL frequency however, was higher in males.
- Overall, regardless of age, pulp and dentine caries rates were higher in males, but enamel caries and particularly fillings, were more common in females. When age groups were considered separately, dentine caries frequencies were higher in males of all age groups and fillings in females of all age classes. Pulp lesions more frequently attacked females of the older age group only and males of the other two classes, whereas enamel caries more often

affected young females of the young age group and males of the two older classes.

- The pattern of distribution of lesions within age groups was similar between the sexes. Dentine lesions were the most common type of lesion (fillings excluded) in the young age group for both sexes followed, however, by enamel caries in females and pulp lesions in males. Dentine lesions in the middle adult age group and pulp exposing lesions in the older age group were the most frequently observed types (fillings excluded) for both sexes. Filling rates were higher than any other type of lesion in females of all age groups and in males of the middle and older age classes. When distribution within the dentition was considered, there were some differences between the sexes. Dentine lesions in females were more frequent in first incisors than any other tooth type, whereas in males were more frequent in posterior teeth. In addition, enamel lesions in females attacked posterior teeth more often, whereas in males equally affected posterior and anterior teeth. Pulp lesions and fillings were more common in the posterior teeth of both sexes. In females, pulp lesions and fillings predominated in the upper dentition and dentine, and enamel in the lower dentition, whereas in males, pulp, dentine and enamel lesions were more common in the mandibular teeth and fillings in the maxillary teeth.

- Occlusal crown sites were more frequently affected than side sites of the crown and the root, in both sexes. The most commonly attacked sites of carious lesions were pit sites, followed by occlusal surfaces, whereas the least affected were root surfaces, followed by smooth surfaces, for both sexes.

- Occlusal surface, pit and occlusal attrition facet caries affected females more than males, whereas contact, smooth and root caries attacked male more often than female individuals. The biggest difference was observed in pit caries and the smallest in smooth surface caries.

- The distribution of caries between anterior and posterior, and the upper and lower dentition, was very similar between the sexes. Caries on all tooth sites affected the posterior teeth more than the anterior. Mandibular teeth were attacked more frequently by lesions on most tooth sites, except contact sites and root surfaces in females, smooth surfaces in males, and occlusal attrition facets in both sexes.

- In most cases, carious lesion rates steadily increased with age. However, in the case of occlusal surface and pit caries in females, the frequency increased from young to middle but decreased in older individuals; also, pit, contact and smooth surface caries rates in males decreased from young to middle and again rose in the older age group.

Between SES groups

- Both the proportion of teeth and the number of individuals attacked by caries were slightly higher in the high SES group. The same trend was observed, when only cavitated lesions were considered. Additionally, more high SES individuals had one decayed tooth only, but the differece was again small. Gross caries were recorded in a considerably larger number of individuals from the low SES group.

- When age groups were considered separately, teeth of the high SES group were more often affected by caries in all three of them, especially in the youngest age class, in which the difference was very marked. AMTL rates, on the other hand, were higher for the low SES group in all age classes, but the difference in the frequency was more marked in the young and older adults.

- Posterior teeth were more often involved (caries and AMTL) than anterior, in both SES groups. AMTL affected the upper dentition of both low and high SES individuals more frequently, whereas caries attacked mandibular teeth more often in low SES and maxillary teeth in high SES.

- Overall, regardless of age, pulp and enamel lesions, and fillings were more common in the high SES group, whereas dentine lesions were the only form than affected low SES teeth more often. When age groups were considered separately, pulp lesions affected low SES teeth of young and middle adults, and high SES teeth of older adults more often; dentine caries were more frequently observed in high SES teeth of young and older individuals, and low SES teeth of middle individuals; fillings were more common in high SES young and middle adults and low SES older adults; and finally, enamel caries were more often present in the teeth of low SES young and older individuals and those of high SES middle adults.

- Some important similarities and differences were noted between the two SES groups in the pattern of distribution of lesions within age classes. In the young age class, dentine lesions were the most common form for low SES individuals, followed by fillings, pulp and enamel lesions, whereas for high SES, fillings were the most frequently observed form, followed by dentine, pulp and enamel lesions. Fillings were more common than any other type of lesions in middle and older adults of both SES groups. Pulp and dentine lesions affected middle adults of low SES more often than enamel caries, whereas for high SES, enamel lesions were the most frequent form (except fillings) and pulp lesions the least frequent. The exact opposite trend was observed in the older age group. In both SES groups, enamel lesions were rare in the first two age classes, with middle adults being the most frequently affected age group, and did not affect older adults. Pulp lesions steadily increased with age in both SES groups. This was also the case for fillings in the low SES, whereas in the high SES group, fillings' rates decreased as age progressed. All lesion forms in both SES groups, except for high SES enamel caries, predominated in the posterior teeth. In the low SES group, pulp lesions and feelings predominated in the upper dentition, whereas dentine and enamel lesions were more common in the lower dentition. In the high SES group, only fillings were more regularly observed in maxillary teeth.

- Occlusal crown sites were more frequently affected than side sites of the crown and the root, in both SES samples. The most commonly attacked sites were pit surfaces for low SES and occlusal surfaces for high SES; it should be noted however, that the difference between occlusal and pit surfaces in caries rates were quite small. The least affected sites were root surfaces for both SES groups.

- Caries affected the high SES sample more frequently than the low SES, in all the surfaces of the tooth, and the differences, especially in occlusal, pit and contact surfaces, were very marked. The biggest difference was observed in occlusal surface caries and the smallest in root caries.

- Occlusal, pit, occlusal attrition facet, contact, smooth and root caries predominated in the posterior teeth in both SES groups. The upper dentition was attacked more frequently by caries in occlusal attrition facets, contact sites and smooth surfaces of the low SES sample, and the occlusal attrition facets, contact sites and root surfaces of the high SES sample. Occlusal, pit and root caries in the teeth of low SES individuals and occlusal, pit and smooth caries in the teeth of high SES individuals, were more common in the mandibular dentition.

- Carious lesions increased as age progressed only in the case of occlusal attrition facets in low SES individuals and occlusal surfaces in high SES individuals. The most common pattern was when caries frequency decreased from the young to the middle age class and again increased in older individuals; this was observed in contact and smooth caries in the low SES group and in pit, occlusal attrition facet, smooth and root caries in the high SES group. In the case of low SES occlusal and root caries, the rates increased in the first two age groups and decreased in older adults. Pit caries' rates in low SES teeth steadily decreased as age progressed, whereas in high SES contact caries, the frequency remained the same in the first two age classes and rose in older individuals.

6.1.2.2.2 Discussion

In the 20th century population, the proportion of teeth attacked by caries was almost equal for females and males; however, a considerably larger number of male individuals was affected by the condition. When only cavitated lesions were considered, the percentage of teeth attacked was slightly higher for females, but again, there was a significantly larger number of male individuals affected (χ^2=5.954 p=0.015). Furthermore, more males had gross cavities and more than one decayed tooth (χ^2=0.424 p=0.515). When age groups were considered separately, males exhibited higher rates in the young and older adult groups and females, in the middle adult group. Male teeth were more often missing antemortem. Pulp and dentine lesions affected males more than females, whereas the opposite was the case for enamel lesions and most importantly, fillings (χ^2=30.019 p=0.000). Dentine lesions were more common in males of all age groups and fillings, in females of all age groups. Pulp lesions affected females of the older age class more often than males and males of the young and middle age classes more than females. Occlusal, pit and occlusal attrition facet caries attacked female teeth more frequently than the male teeth, whereas the opposite was the case for contact and root caries; smooth caries rates were equal between the sexes.

The results, therefore, do not support the hypothesis that the levels of caries would be higher for females, as a result of their biological tendency to have a more cariogenic oral environment, the higher consumption of meat by males, women's habit of snacking between meals, and the earlier eruption of female teeth (Hillson 2006; Lukacs & Largaespada 2006). Oral hygiene was possibly one of the significant contributing factors to the severer caries affliction of males. Studies have reported a more pronounced preventive oral health behaviour for females (Coda Bertea *et al.* 2007). Women follow oral hygiene recommendations more thoroughly and draw upon more dental care than men (Al-Omari & Hamasha 2005; Fukai *et al.* 1999). This behaviour involves both more frequent visits to the dentist and more attention to personal oral hygiene practices (Coda Bertea *et al.* 2007).

Research, however, has yielded the paradox that, although women take more care of their teeth, they do not have a better oral health than men (Al-Omari & Hamasha 2005; Coda Bertea *et al.* 2007). Even though this is a common finding, in the present study, males are more severely affected by the condition. It can be assumed that some dietary factor contributed to this sex variation but there is no indication that the male diet was more cariogenic than the female diet in 20th century Greece (Arvaniti *et al.* 2006; Georgakis 2001; Mantis 2001; Matalas 2001; Trichopoulou & Lagiou 2001). Moreover, considering that the difference observed between the sexes was not a substantial one, the factor of oral hygiene might well have resulted in a somewhat different pattern than the one expected.

In the modern population, again, both the proportion of teeth and the number of individuals attacked by caries were slightly higher in the high SES group, but the difference was not statistically significant (χ^2=7.424 *p*=0.060). The same trend was observed, when only cavitated lesions were considered (χ^2=6.016 *p*=0.111). However, more high SES individuals had one decayed tooth only, but the difference was again small. Gross (pulp-exposing) caries however, were recorded in a considerably larger number of individuals from the low SES group (χ^2=1.362 *p*=0.715). When age groups were considered separately, teeth of the high SES group were more often affected by caries in all three of them, especially in the youngest age class, in which the difference was very marked. AMTL rates, on the other hand, were higher for the low SES group in all age classes, but the difference in the frequency was more marked in the young and older adults. Overall, regardless of age, pulp and enamel lesions, and fillings were more common in the high SES group, whereas dentine lesions were the only form that affected low SES teeth more often (χ^2=37.391 *p*=0.000). When age groups were considered separately, pulp lesions affected low SES teeth of young and middle adults, and high SES teeth of older adults more often; dentine caries were more frequently observed in high SES teeth of young and older individuals, and low SES teeth of middle individuals; fillings were more common in high SES young and middle adults and low SES older adults; and finally, enamel caries were more often present in the teeth of low SES young and older individuals and those of high SES middle adults. Caries affected the high SES sample more frequently than the low SES, in all the surfaces of the tooth, and the differences, especially in occlusal, pit and contact surfaces, were very marked. The biggest difference was observed in occlusal surface caries and the smallest in root caries. Comparisons between SES groups within each sex subgroup and between the sexes within each SES subgroup were not taken into account because the female samples were extremely small.

The results for SES differences, therefore, support the hypothesis (*Chapter 2*) that the low SES group would present higher caries rates. This can be attributed to a heavier reliance on cheaper foodstuffs, such as carbohydrates, limited access to professional health care and treatment, as well as negative attitudes towards personal oral health care. Regular visits to the dentist with professional treatment, feedback and reinforcement play a very important role in caries development and seem to be the most successful approach to preventing initiation, relapse and disease progression (Loe 2000). In addition, previous studies have demonstrated a strong association between caries severity (Harris *et al.* 2004) and SES and have obtained clear evidence that individuals of lower SES are at increased risk of both being affected by caries and having untreated decay (Polk *et al.* 2010). The SES disparity in caries experience may be partially accounted for by individual oral hygiene behaviours, such as tooth brushing and flossing, and professional preventive interventions (Polk *et al.* 2010). As regards dietary variation in relation to socioeconomic environment, as has already been discussed in *Chapter 2*, carbohydrate and protein consumption very much varied according to SES. The dietary importance of cereals and vegetables, i.e. their contribution to total energy availability, diminished with increasing affluence, whereas the opposite was the case for meat and eggs (Matalas 2001).

6.2. Occlusal Wear

6.2.1 Comparison between Populations

Occlusal wear is expected to be markedly heavier in the Demetrias assemblage due to the harder and much less refined diets of ancient populations compared to industrial ones.

6.2.1.1 Key findings

- The overall difference of heavy wear scores between the ancient and the modern population was very marked. The assemblage from the Hellenistic cemetery presented a much higher frequency of moderate and heavy occlusal attrition than the 20th century sample. More specifically, 39.6% and 45.7% of the teeth from Demetrias showed moderate and heavy wear, respectively, whereas in Athens, the percentages for moderate and heavy wear were 31.2% and only 3.6%, correspondingly.
- When occlusal attrition frequency was considered for each age group separately, it was revealed that moderate wear rates were higher for Demetrias in the young and middle adult age group but lower in older individuals, whereas heavy wear rates were markedly higher for Demetrias in all age groups. The biggest difference was observed in the middle adult age group, in which heavy attrition frequency in the ancient assemblage was approximately twenty-three times higher than that in the modern assemblage.
- The most heavily worn tooth type in Demetrias were first molars (74.5%), whereas in Athens, first incisors had the highest scores of heavy wear in the dentition (7.8%).
- In the ancient sample, mandibular and posterior teeth displayed a higher frequency of heavy wear compared to maxillary and anterior teeth, respectively, whereas in the modern sample, the exact opposite was the case.
- Rates in slight and moderate wear stages 1 to 3 in Smith's system were higher for the modern dental assemblage, whereas rates in moderate and heavy wear stages 4 to 8 were markedly higher in the ancient dental assemblage.

6.2.1.2 Discussion

The rate and pattern of dental wear in a population are strongly related to the nature of subsistence (Hillson 2000, 254). More specifically, the severity of wear is highly influenced by the consistency and texture of food, which is determined by either the characteristics of the food, e.g. the presence of cellulose in plants, the manner of its preparation, or a combination of both (Larsen 1997, 248). This is clearly seen in this study as the very marked difference in severe wear levels between the ancient and the modern population (χ^2=226.114 p=0.000) is apparently the result of the totally different nature of their diet, food processing techniques and consumption (Powell 1985). As has already been discussed in the section on caries, the diet of ancient populations, and Greeks in particular, was based on coarse, abrasive, often uncooked and, predominantly, unrefined food (Beckett 1994, Esclassan 2009; Keenleyside 2008), whereas modern populations' diet is based on soft, refined and cooked food items (Teaford & Lytle 1996). Tough diets tend to create a more powerful chewing, increased chewing time and extensive lateral movements of the jaw that produce heavy wear at rapid rates (Gamza & Irish 2010; Watson 2008). As a result, heavy wear rates in the ancient assemblage were markedly higher than those in the modern one, even when wear is age corrected. The differences between Demetrias and Athens were highly significant statistically in the young (χ^2=347.178 p=0.000), the middle (χ^2=822.272 p=0.000) and the older groups (χ^2=889.759 p=0.000). In addition, dental work in the modern population possibly played a role too, as restorations of the crown continuously replace the surfaces that would have been worn in earlier times (Hillson 2008, 124). The low prevalence of wear in the 20th century dental sample, as well as the relatively advanced wear in the Hellenistic sample, confirm the hypothesis made in *Chapter 2* and are consistent with other studies on both post-industrial (Hugoso *et al.* 1988; Seligman *et al.* 1988) and pre-industrial, agricultural populations (Johansson *et al.* 1993; Scott *et al.* 1991).

Differences between the two populations in the pattern of dental wear within the dentition were also observed. Posterior teeth were more heavily worn in the Hellenistic assemblage, whereas, in the 20th century population, the anterior teeth showed heavier wear. Studies have provided evidence that there is an underlying relationship between the pattern of wear across the tooth row and tooth eruption sequence and, more specifically, as early erupting teeth are inevitably more worn than teeth that erupt later (Deter 2009). The results in the present study confirm this finding, as gradients of wear correspond to the order that teeth erupt and move into functional occlusion in the jaw (Deter 2009).

Although there is considerable variation in eruption sequence and timing, the normal sequence that applies in most populations is the following: M_1 I_1 I_2 C P_1 P_2 M_2 for the lower dentition and M^1 I^1 I^2 P^1 C P^2 M^2 for the upper dentition, with lower teeth emerging earlier than their equivalents in the upper dentition (Hillson 1996, 139-140). Emergence times are grouped into three different phases: (a) emergence of permanent first molars and incisors (5-8 years), (b) emergence of canines, premolars and second molars (9.5-12.5 years) and (c) emergence of third molars (late teens-early twenties) (Hillson 1996, 140). Some pairs of teeth are particularly close in eruption timing (M_1 and I_1; P_2 and P_1; P^2 and M^2) and in such cases, the normal order is frequently reversed (Hillson 1996, 141).

In the present study, although the gradients of wear do not entirely correspond to the order that teeth erupt, the underlying relationship between wear and eruption sequence is still apparent in both populations. Thus, in the archaeological assemblage, first molars, and more specifically lower first molars (i.e. the first permanent tooth type to erupt), were the most heavily worn teeth whereas third molars (i.e. the last permanent tooth type to erupt), and particularly upper third molars were the least worn teeth. In the 20th century assemblage, on the other hand, first incisors (i.e. the second permanent tooth type to erupt) were the most heavily worn teeth, whereas second and third molars (i.e. the last permanent tooth type to erupt) were the least worn teeth.

In the Hellenistic population, it was the posterior teeth (and particularly first molars) that were the most heavily worn in the dental arcade, whereas in the 20th century population, it was the anterior teeth (and first incisors in particular) that exhibited the greatest wear in the dental arcade. This finding is in accordance with studies suggesting that, in contrast to past populations, who experienced pronounced wear throughout the dentition or, predominantly, in the posterior teeth (molars), urban people of post-industrial societies exhibit greater wear in the anterior teeth (Dahl *et al.* 1989; Nystrom *et al.* 1990). It has been suggested that anterior wear becomes accentuated primarily in association with loss of the posterior dentition, as the anterior teeth are being employed masticatory behaviours in compensation for lost functional capabilitites in the posterior teeth (Hinton 1981, 561). Considering that antemortem tooth loss rates of molars in the modern assemblage were very high (66.5%, 59.8% and 59.1% for first, second and third molars, respectively), the loss of posterior dentition could be considered a contributing factor to heavier wear rates for anterior teeth.

However, there are other factors, which may obscure age-related occlusal wear patterns, that should also be taken into account. In modern populations, wear rates and patterns are mainly caused by parafunctions, such as bruxism (tooth clenching and grinding), unbalanced morphological occlusion, unfavourable dentofacial morphology, foods and drinks with low pH, digestive disturbances, or combinations of these factors (Kononen *et al.* 2006), rather than forces produced by chewing, which are relatively weak due to the soft and refined modern diet. Furthermore, it has been suggested that bruxism produces more pronounced effects on the anterior teeth than the posterior (Khan *et al.* 1998). These two factors, i.e. the prominent role of factors other than food mastication in modern populations and the effect of bruxism on the anterior dentition, could explain the heavier wear in the incisor teeth of the population from Athens. In ancient agricultural populations on the other hand, food consumption played a very prominent role in wear rates and patterns since the foods consumed were tough and abrasive. The use of the teeth in eating involves a two-stage process: first, the initial preparation of food with the anterior teeth, and secondly, the reduction of food with the posterior teeth (Larsen 1997, 247); therefore, mastication, during which strong forces are produced, mainly involves the posterior teeth. This provides an explanation for the heavier occlusal wear rates recorded in the posterior teeth of the ancient population.

6.2.2 Comparison among sexes and socioeconomic status groups

The hypothesis is that occlusal wear will be heavier in male individuals as males consumed a tougher diet requiring stronger masticatory forces than females, both in ancient and 20th century Greece. As regards socioeconomic status groups, it is assumed that the differences will not be pronounced, but if mortuary treatment and occupation are strongly associated with status, then occlusal wear should be heavier in members of the lower social group because they possibly consumed less processed food items.

6.2.2.1 Demetrias

6.2.2.1.1 Key findings

Between sexes

- The overall difference of heavy wear scores between the sexes in Demetrias was marked. Males presented a slightly lower frequency of moderate wear but considerably higher frequency of heavy attrition than females. More specifically, 41.3% and 35.5% of the teeth of female individuals showed moderate and heavy wear, respectively, whereas for male teeth, the percentages for moderate and heavy wear were 38.4% and 52.9%, correspondingly.
- When occlusal attrition frequency was considered for each age group separately, it was revealed that moderate wear rates were higher for males in the young age group but lower in middle and older adult individuals. Heavy wear rates, in contrast, were slightly higher for females in the first age class but markedly higher for male individuals in the second and third age group. The biggest difference was observed in the older age class, in which males showed almost twice as much heavy wear as females.
- The most heavily worn tooth type was the first molar for both sexes. Male first molars were more heavily worn (78.8%) than female first molars (68.5%). The same marked difference between the sexes also occurs in the second premolars, which were the second mostly worn tooth type (42.8% for females and 61.2% for males).
- In both the female and the male sample, mandibular and posterior teeth displayed a higher frequency of heavy wear compared to maxillary and anterior teeth, respectively.

- Rates in slight and moderate wear stages 1 to 3 in Smith's system were higher for female individuals, whereas rates in moderate and heavy wear stages 4 to 8 were clearly in the male dental assemblage.

Between SES groups

- Teeth in the low SES assemblage from Demetrias presented a lower frequency of moderate wear but a higher frequency of heavy wear than those in the high SES assemblage. More specifically, 36.2% and 48.2% of the teeth of low SES individuals showed moderate and heavy wear, respectively, whereas for high SES teeth, the percentages for moderate and heavy wear were 43.2% and 43.0%, correspondingly.
- When occlusal attrition frequency was considered for each age group separately, it was revealed that moderate wear rates were higher for low SES in the young age group but lower in middle and older adult individuals. Heavy wear rates, however, were markedly higher for low SES individuals in all age classes. The biggest difference was observed in the older age class, in which the low SES dental assemblage showed more than twice as much heavy wear as the high SES assemblage. It should be noted that the older low SES individuals presented the highest frequency of heavy wear (95.7%) of all subsamples within the populations under study.
- The most heavily worn tooth type was the first molar for both SES groups. Low SES first molars were much more heavily worn (81.0%) than high SES first molars (66.8%). When upper and lower dentitions were considered independently, this difference became greater, with 83.4% of low SES lower first molars and only 29.9% of high SES lower first molars showing heavy wear.

- In both the low and the high SES sample, posterior teeth displayed a higher frequency of heavy wear compared to anterior teeth. Heavy wear rates in the low SES sample were higher in the mandibular dentition, whereas the opposite was the case for the high SES sample.
- Rates in slight and moderate wear stages 1 and 4 in Smith's system were higher for the high SES individuals, but wear frequencies in all the other six slight, moderate and heavy wear stages (2, 3, 5, 6, 7, 8) were higher for the low SES assemblage.

6.2.2.1.2 Discussion

In brief, in the archaeological population, males exhibited heavier wear than females (χ^2=226.114 p=0.000). To understand further the relationship between sex and occlusal wear, comparisons between females and males within each SES group were made. These revealed that both low and high SES male individuals had more severely worn teeth than their female counterparts (low SES: χ^2=73.463 p=0.000 high SES: χ^2=18.959 p=0.000). More specifically, 52.8% of the low SES male teeth and 52.9% of the high SES male teeth showed heavy wear, whereas, for the female teeth these percentages were 41.2% and 29.8%, respectively. At this point, it is also useful to consider the differences found in heavy wear rates between the low and the high SES group. As has already been mentioned, the teeth in the low SES assemblage were more severely worn that the teeth belonging to the high SES assemblage (χ^2=63.682 p=0.000) . Comparisons within each sex group, however, revealed that although in the female sample, low SES teeth were more heavily worn (41.2%) than high SES teeth (29.8%) (χ^2=56.048 p=0.000), in the male sample, the opposite was the case for both heavy (52.8% and 52.9% for low and high SES, respectively) and moderate wear (35.4% and 41.8% for low and high SES, respectively) (χ^2=30.713 p=0.000). In order to avoid age bias the same comparisons were made for each age group separately. The more reliable results produced finally revealed that heavy wear rates were higher for the high SES assemblage only in the young age class, whereas in the middle and older age classes, low SES teeth were more heavily worn that high SES teeth. More specifically, the heavy wear frequencies for low and high SES groups were the following: 19.6% and 22.3% for young (χ^2=29.256 p=0.000), 65.4% and 52.7% for middle (χ^2=71.961 p=0.000) and 100.0%, and 72.4% for older adults (χ^2=43.218 p=0.000), respectively. For females, low SES teeth were more severely worn than high SES teeth in all age groups; the frequencies for low and high SES were the following: 24.4% and 21.4% for young, 47.5% and 36.4% for middle and 84.6% and 36.4% for older adults, respectively.

To summarise all the above, the results indicate that males and low SES individuals displayed heavier wear than females and high SES individuals, respectively. This was also the case for males of both low and high SES and low SES individuals of both sexes. The most severely worn teeth were those coming from the low SES male assemblage. While males displayed very similar rates, both in the low and the high SES group, the differences between low and high SES females as well as between high SES males and high SES females were marked. First, it is evident that there is a dietary variation between the sexes and the two SES groups. This is consistent with the results produced for dental caries, which point towards a different diet for the socially privileged groups, i.e. males and high SES individuals (both females and males). Results for occlusal wear on the other hand, indicate subsistence differences for males, a socially privileged group, and low SES individuals (both females and males), a socially disadvantaged group. While according to caries distribution within the population, the dietary variation is associated with different levels of cariogenicity of the foods consumed, wear population patterns are attributable to differences in the consistency and texture of foods. Although one (i.e. caries) does not preclude the other (i.e. wear), most of the foods and drinks that were presumably consumed by males and the members of the high status group, and that predisposed to more numerous and severer carious lesions in the samples representing the socially privileged, do not cause heavier wear rates. Therefore, the source of this variation should be sought elsewhere.

As has been discussed earlier in this chapter, the attitudes of ancient Greeks to women's access to foods suggest that women consumed less meat, fish and aquatic food in general, as well as wine and wine in combination with wine, etc. (Garnsey 1999; Prowse *et al.* 2005). This agrees with the pattern found in occlusal wear data, as the more regular consumption of all of these food and drink items may be responsible for the variation observed between the sexes. Although meat is not hard and abrasive, it is recognised as a tough substance in that it requires a significant amount of work to cut or fracture it (Lucas & Peters 2000). Thus, whereas meat is not hard enough to scratch the enamel surface, it has an indirect effect, that is to say tooth-on-tooth abrasion due to the extreme mechanical demands required for its mastication (El-Zaatari 2008; 2010). The consumption of tough foods also entails mastication and, hence, tooth-on-tooth contact for a prolonged period of time. In addition, heavier wear in meat-eaters, i.e. males in this study, may be also affected by non-meat items, such as bone, sometimes chewed with the meat (El-Zaatari 2010). Moreover, the reliance on fish, particularly if dried, and other marine foods, such as shellfish, has been connected to high rates of heavy wear, in association with a high content of grit (Littleton & Frohlich 1993). Finally, wine may have also contribute to heavier wear in males, as it has an erosion potential (Albashaireh & Al-Shorman 2010), which indirectly influences occlusal wear severity. More specifically, the erosion potential of wine, in consequence of its low pH, makes dentine (exposed by attrition) vulnerable to acidic attacks that remove the dentine structure, leaving behind thin walls of enamel surrounding the wear lesion (Albashaireh & Al-Shorman 2010).

According to literary sources, access to meat, aquatic foods and possibly wine was more frequent for the well-off members of ancient Greek society (Garnsey 1999; Wilkins & Hill 2006). Based on this piece of information, a higher frequency of heavy wear would be expected for the high SES assemblage. However, other factors most likely played a more significant role in the variation found between the SES groups. These were mainly associated with the preparation and processing of foods rather than with their natural characteristics, although the latter were also important. As has already been extensively discussed, in the section on caries, the affluent families consumed a higher quality of cereals and, also, more refined and processed foods in general. In brief, the well-off consumed soft, white, wheat-based bread, whereas the poor ate hard, black, unleaved barley or rye bread. The great masticatory force required for the ingestion of hard food items results in heavy wear (Watson 2008). In addition, studies on molar microwear have shown that a diet of harder objects, such as hard seeds and husked grains, results in heavily pitted tooth surfaces (El-Zaatari 2010). This finding is of particular importance since there is a strong association between tooth microwear and gross dental tissue loss (Schmidt 2010).

The affluent also consumed cooked food much more often than their poorer counterparts; using pottery to boil or heat foods in earthen ovens would have also contributed to a generally softer diet (Deter 2009, 251) that requires less powerful mastication and also little chewing time. In addition, since the diet of the wealthy was more often cooked and much more refined compared to that of the poor, they most likely consumed more fresh than dried food, succulent versus tough meat, etc. Moreover, part of their diet might have required less processing; for instance, farmed crops, which were more often available to the privileged (Scheidel 1995; Wilkins & Hill 2006), required less manipulation for consumption, possibly creating softer and more refined diets, which in turn could produce less dental wear (Deter 2009, 250-251).

It is of interest to note that the highest heavy wear rates were observed in the low SES males whereas the lowest heavy wear rates were found in the high SES females; this finding ties in with the above-discussed arguments on the factors responsible for both sex and SES differences in Demetrias. Females, and high SES females in particular, ate less meat than their male counterparts; this explains heavier wear in high SES males (and in low SES males as well). However, high SES females also consumed more refined, fresh and cooked foods than their low SES counterparts; this provides an explanation for the heavier wear rates in low SES females (and low SES males for that matter).

Another interesting finding is that there seems to be no clear indication of an inverse relationship between occlusal wear and caries, which is seen in other populations as a result of the cleansing effect achieved when the rate of wear is more rapid than the rate of caries progression (Maat & van der Velde 1987). The competitive relationship between progress of caries and occlusal wear has been disputed, however, and their relationship should not be overgeneralised (Buzon & Bombak 2010; Larsen 1997). In the present study, it seems that the two conditions remain independent variables and that they correlate with diet independently (Buzon & Bombak 2010). For instance, both heavy wear and caries prevalence is higher in the male than the female dental sample. In contrast, comparisons between SES groups have showed that, whereas carious lesions more severely affected the high SES sample, wear was heavier in the low SES sample. This could be attributed either to the competitive relationship between progress of wear and caries or to totally independent dietary factors, i.e. cariogenic food and drink items for the high SES group and hard-textured foods for the low SES; it is also possible that both factors contributed to this outcome.

6.2.2.2 Athens

6.2.2.2.1 Key findings

Between sexes

- In Athens, males presented a higher frequency of both moderate and heavy wear than females. More specifically, 29.2% and 2.0% of the teeth of female individuals showed moderate and heavy wear, respectively, whereas for male teeth, the percentages for moderate and heavy wear were 32.6% and 4.8%, correspondingly.
- When occlusal attrition frequency was considered for each age group separately, it was revealed that both moderate and heavy wear rates were higher for males in all age groups. The biggest difference was observed in the older age class, in which males showed more than two and a half times more heavy wear as females.
- The most heavily worn tooth type was the first incisor for the female sample (8.6%) and the second incisor for the male sample (8.1%).
- In the female assemblage, mandibular and anterior teeth displayed a higher frequency of heavy wear compared to maxillary and posterior teeth,

respectively, whereas in the male assemblage, the maxillary and anterior dentition was more frequently affected by heavy attrition.

- Rates for females were higher in wear stages 2, 7 and 8 in Smith's system, and for males, in stages 1, 3, 4, 5, and 6.

Between SES groups

- Teeth in the low SES assemblage from Athens presented a lower frequency of moderate wear but a higher frequency of heavy wear than those in the high SES assemblage. More specifically, 24.5% and 5.8% of the teeth of low SES individuals showed moderate and heavy wear, respectively, whereas for high SES teeth, the percentages for moderate and heavy wear were 54.3% and 3.9%, correspondingly.
- When occlusal attrition frequency was considered for each age group separately, it was revealed that moderate wear rates were higher for low SES in the young age group but considerably lower in middle and older adult individuals. Heavy wear rates, however, were markedly higher for low SES individuals in all age classes. The biggest difference was observed in the older age class, in which the low SES dental assemblage showed almost eight times as much heavy wear as the high SES assemblage.
- The most heavily worn tooth type was the first molar for the low SES group and the second premolar for the high SES group. Low SES first molars were much more heavily worn (16.7%) than high SES second premolars (1.6%).
- In the low SES sample, the lower dentition and the anterior teeth were more heavily worn than the upper dentition and the posterior teeth, respectively, whereas the exact opposite was the case for the high SES sample.

- Rates in slight and heavy wear stages 1, 2, and 5 in Smith's system were higher for the low SES individuals, whereas wear frequencies in moderate and heavy wear stages 3, 4, 6 and 7 were higher for the high SES assemblage. Percentages for heavy wear stage 8 were equal to zero (0.0%) in both SES assemblages.

6.2.2.2.2 Discussion

To summarise the results for the modern population sample, the teeth of males were more heavily worn than those of females ((χ^2=19.790 p=0.000)). The same pattern was also observed in the ancient population. As has been mentioned in the *Chapter 2*, the main difference in food distribution between the sexes in 20th century Greece, was observed in the consumption of meat by males (Arvaniti *et al.* 2006; Βαρδάκη 2001). This is the reason the hypothesis was that male individuals would show heavier wear rates, since meat is a tough food and requires powerful chewing (El-Zaatari 2008). The hypothesis was finally supported by the results and the explanation of males eating more meat than females is strongly supported by studies on the social role of women and the symbolic denotation of meat consumption (Βαρδάκη 2001).

As far as the difference between the two SES groups is concerned, the low SES sample displayed heavier wear than the high SES sample (χ^2=104.892 p=0.000). If the finding that carious lesions were more common and severer in the high SES group is taken into account, it can be argued that the well-off consumed more refined and softer foods than their poorer counterparts and therefore the latter were less often affected by caries but, at the same time, they showed evidence of heavier wear. The differences between sexes within SES groups and between SES groups within each sex sample were not taken into account because the samples for female individuals were extremely small and were therefore not considered reliable.

6.3 Periodontal Disease

6.3.1 Comparison between populations

The hypothesis is that periodontal disease possibly affected the modern population more severely than the ancient, due to the higher consumption of refined carbohydrates and poor immune response impaired by psychosocial stress, tobacco use, obesity, diabetes, and an unhealthy diet, in the former.

6.3.1.1 Key findings

- The dental assemblage from the contemporary cemetery was more frequently attacked by both gingivitis and periodontal disease; the only exception was in the proportion of individuals affected by gingivitis, which was slighlty higher in the ancient assemblage (24.3% for Demetrias and 23.8% for Athens). The differences in the frequency of areas affected by gingivitis (21.9% for Demetrias and 33.1% for Athens, respectively) and periodontitis (46.9% for Demetrias and 61.3% for Athens), and individuals exhibiting periodontitis (58.1% for Demetrias and 75.2% for Athens) were considerable but not as marked as one would expect.
- When comparisons were made within each age-group, gingivitis was more common in Demetrias in the middle and older age classes, whereas periodontitis rates were higher in the ancient population in the young age-group only.

- In the ancient population, overall gingivitis rates markedly increased from the young to the middle adult age group but slightly decreased from the middle to the older adult age group; periodontitis frequency steadily increased with age. In the 20th century sample, gingivitis rates on the other hand, were markedly higher in the young age group, compared with the other two, whereas the middle-adult individuals displayed the lowest rates of the condition; periodontitis rates increased from the first to the second age class but decreased in the third group.

- When comparisons between the two populations were made for each category, gingivitis, acute phase, and progressive periodontitis rates were higher for Athens but only slightly for the latter category, whereas, quiescent phase periodontitis was considerably more common in Demetrias.

- In both assemblages, mandibular interseptal areas were more susceptible to gingivitis but less susceptible to periodontitis, than maxillary areas.

- In Demetrias, both gingivitis and periodontitis affected the anterior interseptal areas more frequently than the posterior. In Athens, gingivitis was two times more common in the posterior interseptal areas, whereas periodontitis occured more frequently in the anterior areas.

- The distribution of lesions on the left and right sides of the dentition was very similar for both populations.

6.3.1.2 Discussion

Previous studies of prevalence and natural history of periodontal disease in past human populations found no evidence of a higher prevalence than in modern societies. For example, the prevalence of periodontitis appears to have remained practically constant during the past 3000 years in Britain, despite the fact that considerable changes in the oral environment must have occurred (Meller *et al.* 2009). The significance of these findings regarding untreated populations in underdeveloped countries is nowadays considerable (Kerr 1998). In the present study, the results suggested differences in the prevalence of periodontitis between the ancient and the modern population (χ^2=1027 p=0.000), which, however, were not as marked as one might expect, considering the completely different conditions in which the Hellenistic Greeks once lived. In spite of the fact that this variation was not even remotely as important as that observed for dental caries, it should be pointed out that it indicates that there are determinants (unmodifiable) and susceptibility or risk factors (modifiable) that affected the prevalence and distribution of periodontitis between but also, within populations.

One very decisive determinant is age. Studies of periodontal disease prevalence, extent, and severity reveal more severe manifestations of gingivitis and periodontitis in older age groups compared with younger groups, suggesting age-related effects (Abdellatif & Burt 1987; Grossi *et al.* 1994; Grossi *et al.* 1995). Most studies, however, show that periodontal disease is more severe in the elderly because of its cumulative destruction over a lifetime, rather than age-related intrinsic deficiency or abnormality that affects susceptibility to periodontitis infection (Genco 2000). For example, an analysis of the epidemiologic data from the National Health and Nutrition Surveys (NHANES) in the United States concluded that when oral hygiene status was considered, age was not an important factor in determining periodontal disease (Abdellatif & Burt 1987). The results of several longitudinal studies addressing the cumulative nature of periodontal attachment loss, suggest that the rate of periodontal destruction has been the same throughout adulthood (Machtei *et al.* 1994; Wennstrom *et al.* 1993). It thus appears that, although there might be an increased risk of peridontal disease with advanced age, age per se, is not an intrinsic risk factor (Genco 2000). In the present study, progression of periodontitis with age was not a consistent finding, although it appears that there was some relationship between age and the frequency of the condition in some of the sub-groups, especially in the first two age classes (young: χ^2=1050.552 *p*=0.000, middle= χ^2=845.195 *p*=0.000, older: χ^2=64.289 *p*=0.000). Moreover, the modern assemblage included a considerable number of edentulous individuals or individuals with most of their tooth sockets remodelled and therefore, not included in the study; a proportion, or, most possibly, all of them, might have been affected by the condition to some extent. Thereby, the longer lifespan of the modern population, might have been a determinant influencing the distribution of periodontal disease between populations, though not a decisive one. The higher rates of periodontitis in the ancient population in the young age group, possibly indicates that improvement of life expectancy, postponed the manifestation of the disease in older ages in the modern population.

Non-industrial groups masticating hard foods possess edge-to-edge bite, whereby the upper teeth come into greater occlusal contact with lower teeth. In contrast, industrial groups consuming soft foods have high frequencies of occusal abnormalities and crowding (e.g. overjet, overbite, crossbite, tooth impaction, tooth rotation) (Larsen 1995). The importance of this difference lies in the indication of numerous studies that malocclusions have a negative effect on periodontal health (Helm 1989). The plaque accumulation between malocclusions and non-malocclusions has been compared and, in most cases, greater plaque accumulations and periodontitis evidence were found in association with greater crowding (Bollen 2008; Buckley 1972; Onyeaso *et al.* 2003; Shinberg *et al.* 1991). Thereby, the higher periodontitis rates observed in

Athens could have been partly the result of a more regular occurrence of malocclusions in the modern compared to the ancient population.

A relationship between oral hygiene and periodontitis has been demonstrated in several studies, which have shown that the incidence of the condition can be reduced by controlled oral hygiene (Greene 1963; Jain *et al.* 2009; Socransky 1970). The results of other studies, however, have revealed that the subgingival microbiota did not change with an enhanced bacterial colonization, and that the counts of bacteria associated with periodontitis did not increase (Baumgartner *et al.* 2009). The maxillae and mandibles examined in the Demetrias assemblage had not been influenced by sophisticated oral hygiene practices and yet, there were no signs of quiescent phase and progressive periodontitis in over than 7.2% and 0.3% of interseptal areas, respectively. Furthermore, the difference between the two populations was generally not marked, especially in the most advanced stage of the condition, whereas quiescent phase periodontitis was considerably more common in the ancient sample.

It might be argued that greater contrasts between populations would have been observed, had oral hygiene played a prominent role. Therefore, other factors compensated for the lack of access to personal and professional oral hygiene practices. The primary explanation for this outcome, that is firstly, the low incidence of advanced periodontal disease in the ancient population despite the lack of sophisticated oral hygiene practices and secondly, the relatively small difference between populations, must be the absence of refined carbohydrates in the diet of the Hellenistic population. This is supported by studies, which provide evidence that oral hygiene is a very important factor and can decrease the incidence of periodontal disease only in populations that maintain a

Western-type of diet rich in refined carbohydrates, especially sugar, and low in anti-inflammatory foods (Baumgartner *et al.* 2009). It has also been observed that bursts of periodontal disease activity are soon brought under control, without any treatment, by mechanisms unknown (Hirsch & Clarke 1989). Moreover, it should be noted that a significant number of individuals from the modern population lived a large part of their lives in the first half of the 20^{th} century, when oral hygiene care, both personal and professional, was not as advanced as in the second half of the century (Konig 2004). In fact, it may not differ immensely from that of Hellenistic Greece.

Some researchers suggest that there is no relationship between periodontitis and carbohydrate-rich dietary influences (Tsilivakos 2002) and that, on the contrary, the disease may be associated with high protein/fat diets (Costa 1982). The opposite, traditional view, however, is supported by stronger evidence. Like dental caries, periodontal disease is rare among animals living in the wild, but common among captive and domesticated animals (Colyer 1947). This is the result of the former living on a diet scarce in carbohydrates, whereas the latter consume a diet containing 30% to 50% carbohydrates (Logan 2006). Experiments on rats have revealed that, when sucrose was replaced with lard in the diet, the periodontal soft tissue lesions of these rats were reduced by 90% and the calcified periodontal tissue lesions by 75% (Shaw & Griffiths 1961). The findings led the investigators to report that a no-carbohydrate diet prevents the initiation of periodontal lesions in the soft tissues for at least 20 weeks (Shaw & Griffiths, 1961). Controlled human experiments provided evidence that moderate reduction in carbohydrate intake reduced gingivitis scores by one-third (Cheraskin & Ringsdorf, 1963). This evidence is also consistent with rapid periodontal disease onset in hunter-gatherers that switched to a Western diet (Hujoel 2009). Diabetes, a marker of abnormal blood glucose metabolism, and obesity, a marker of excessive fermentable carbohydrate intake have been associated with markers of periodontal disease in both children and adults (Lalla *et al.* 2006; Reeves *et al.* 2006). Physical activity, which decreases blood glucose levels, has been related to a reduced risk of destructive periodontal disease in adults (Merchant *et al.* 2003).

Therefore, theoretically, the regular consumption of fermentable carbohydrates might have been one of the factors contributing to higher periodontitis rates in the modern population. The results of the study, however, suggest that this dietary variation did not have a major effect on the periodontal status of the populations. The difference between the populations was small compared to that observed for dental caries, and considering that modern people consume large amounts of refined carbohydrates. Furthermore, the proportion of available surfaces affected by the condition in the ancient assemblage was relatively high, whereas for caries, it was quite low. If fermentable carbohydrate consumption had been a major contributing factor in the development of periodontal disease, then periodontitis would have followed the same pattern observed for caries. Moreover, in support of this view, the results for periodontitis within the ancient population contradict those for caries. Whereas the individuals more frequently affected by caries were those that belonged to the socially advantaged segments of the society, i.e. the high SES group as a whole and males of the high SES group, those more severely affected by periodontitis were members of the socially disadvantaged segments, i.e. the low SES group as whole and females of the low SES group.

The absence of significant horizontal alveolar bone loss in premodern and modern populations, who did not or do not practice dental hygiene, casts serious doubt on the concept of a primary role for bacteria in the aetiology of horizontal crestal bone resorption (Hirsch & Clarke 1989, 713). It is thus becoming increasingly clear that immune response plays a decisive role in the clinical outcome of our encounters with microorganisms (Kilian *et al.* 2006). Microbial dental plaque is the main aetiological agent in chronic inflammatory periodontal diseases but the actual form of disease progression depends on the host defences to this challenge (Offenbacher *et al.* 2008). Systemic (environmental) factors that diminish gingival nutrition, optimal tissue replacement and repair, and basic host defense mechanisms are the determinants of the spread of gingivitis to the deeper tissues. Psychosocial stress, tobacco use, obesity, diabetes, and unhealthy diet in modern populations are known to impair host defenses and, in association with the ageing process, promote chronic diseases in general (Hirsch & Clarke 1989, 173; Kinane & Marshall 2001; Offenbacher *et al.* 2008). This presumably constitutes another contributing factor, possibly a very important one, to the more common occurence of periodontitis in the 20th century population, and it could also explain the differences noted between sub-groups in the ancient population, which will be discussed later.

In summary, the higher frequency of periodontitis in the 20th century assemblage appears to be associated with predisposing factors, such as age, malocclusion, oral hygiene, fermentable carbohydrate consumption, and immune response comprised by smoking, diabetes, obesity, unhealthy diet, and stress (Clarke *et al.* 1986; Morita et al. 2010; Offenbacher *et al.* 2008). These, however, apparently do not have a great impact on the periodontal health of the modern population, when this is compared to that of the ancient one. Considering the totally different environmental conditions, oral hygiene practices and dental treatment, the prevalence of periodontal disease affecting individuals of the Hellenistic period is little different to that seen in the modern population. In the untreated ancient population, the oral environmental factors do not appear to affect greatly the incidence and prevalence of the condition. These findings are in accordance with those by Kerr (1998a; 1998b) and Tsilivakos (2002), who also observed relatively small differences between ancient and modern British and Greek populations, respectively. Diet, in terms of fermentable carbohydrate (refined sugar in particular) consumption, appears not to have directly influenced the periodontal status of the contemporary sample, or at least, not substantially. However, modern diet, in combination with other parameters, may have had an indirect impact on periodontal health by impairing the immune response of the population.

6.3.2 Comparison among sexes and socioeconomic status groups

Males should exhibit a higher prevalence of gingivitis and periodontitis in both populations, as the condition is regularly reported to be more prevalent in males than females, regardless of socioeconomic status. If the presence/absence of grave goods and occupation reflect status, then it is expected that periodontitis prevalence will be higher in the low status individuals their greater reliance on carbohydrates.

6.3.2.1 Demetrias

6.3.2.1.1 Key findings

<u>Between sexes</u>

- The overall frequency of interseptal areas with gingivitis was higher for females (25.2% for females and 19.4% for males), but a higher proportion of male individuals exhibited lesions characteristic of the infection (16.0% for females and 28.6% for males). Periodontitis affected more female interseptal areas (48.8% as opposed to 45.5% for males) and female individuals (64.0% as opposed to 55.1% for males).

- When the sexes were compared in each age group separately, gingivitis was markedly more common for females in the first and second age classes; in the older age group however, females were not affected, whereas more than half of the interseptal areas of male individuals showed signs of the inflammation. Periodontitis affected females of the young and older age groups more frequently than their male counteparts; in the middle adult age class, males were more commonly affected than females of the same age group.

- The overall frequency of periodontitis in females and gingivitis in males steadily increased with age. The rates of periodontitis in males and gingivitis in females increased from the young to the middle age group but decreased from the middle to the older.

- When comparisons between the two sexes were made for each category, gingivitis and acute phase periodontitis rates were notably higher for females, whereas, quiescent phase and progressive periodontitis was markedly more common in males.

- In both sex samples, mandibular interseptal areas were more susceptible to gingivitis but less susceptible to periodontitis, compared with interseptal maxillary areas.

- In the female sample, both gingivitis and periodontitis affected the anterior interseptal areas more frequently than the posterior. In the male sample, gingivitis was slightly more common in the posterior interseptal areas, whereas periodontitis more frequent in the anterior areas.

- The distribution of lesions on the left and right sides of the dentition was very similar for both sexes.

Between SES groups

- The overall frequency of interseptal areas with gingivitis was more than 3.5 times higher for the high SES group (9.9% for low and 35.7% for high SES), and also a markedly higher proportion of high SES individuals exhibited lesions characteristic of the infection (8.1% for low SES and 40.5% for high SES). The exact opposite was the case for periodontitis, which affected a markedly higher percentage of both low SES interseptal areas (71.2% for low and 19.1% for high SES) and individuals (78.4% for low and 37.8% for high SES).
- When the SES groups were compared in each age category separately, the high SES group exhibited higher frequency rates of gingivitis in all age classes, whereas periodontitis was more markedly common in the low SES group, again in all three age classes.
- In both the low and the high SES sample, the overall frequency of gingivitis increased from the first to the second age group but decreased from the second to the third. Periodontitis frequency in the low SES assemblage decreased from the first to the second age class but increased in the third; in the high SES assemblage, the rates steadily increased with age.
- When comparisons between the two SES samples were made for each category, acute phase, quiescent phase and progressive periodontitis were more common in the low SES group, whereas only gingivitis rates were higher for the high SES group.

- In the low SES sample, mandibular interseptal areas were more susceptible to gingivitis but less susceptible to periodontitis, whereas the exact opposite was the case for the high SES sample.
- In the low SES assemblage, gingivitis affected the posterior interseptal areas more frequently than the anterior, whereas the opposite was the case for periodontitis. On the other hand, in the high SES sample, gingivitis affected the anterior interseptal areas more frequently than the posterior, whereas periodontitis was more common in the posterior rather than the anterior interseptal areas.
- The distribution of lesions on the left and right sides of the dentition was very similar for both SES groups.

6.3.2.1.2 Discussion

In order to understand better the relationship between periodontal disease and biological and social factors, i.e. sex/gender and socioeconomic status, further comparisons within each subgroup were made. It has been previously mentioned that periodontitis affected females, regardless of socioeconomic status, more frequently (25.2% of interseptal areas) than males (19.4%) (χ^2=31.584 *p*=0.000). When these between-sexes comparisons were made within each SES group separately, the results showed that low SES females displayed signs of the condition in a markedly higher percentage of interseptal areas (84.5%) than their male counteparts (61.7%) (χ^2=43.879 *p*=0.000), whereas high SES females were less frequently affected (12.0%) than males (25.0%) (χ^2=15.730 *p*=0.003). The frequency of individuals with periodontitis was higher in low SES females (91.7%) than low SES males (72.0%), whereas in the high SES group, the two sexes were almost equally affected (38.5% of females and 37.5% of males). Between-SES groups comparisons within sex, showed that the frequency of both interseptal areas and individuals was markedly higher for the low SES group in both sexes (females: χ^2=140.606 p=0.000, males: χ^2=47.359 p=0.000). Thus, low SES females (84.5% interseptal areas and 91.7% individuals) and low SES males (61.7% interseptal areas and 72.0% individuals) were more commonly affected than high SES females (12.0% interseptal areas and 38.5% individuals) and high SES males (25.2% interseptal areas and 37.5% individuals).

Accordingly, the most severely affected subgroup was that of low SES females and the least severely affected that of high SES females; the greatest difference observed was between these two groups, that is, the low and the high SES females, wheras the smallest difference was between low SES females and males of the same SES group. In brief, those more severely affected by periodontitis were the members of the socially disadvantaged segments, i.e. the low SES group as whole (regardless of sex) and females of the low SES group. Interestingly, the exact opposite was the case for dental caries, which affected the groups that represented the socially advantaged segments of the society, that is to say, the high SES group as a whole (regardless of sex) and males of the high SES sample, more severely. This contrast is worthy of note, as it provides insight into the issue of periodontal disease prevalence and distribution between and within the populations under study. In view of the fact that dental caries is strongly related to carbohydrate consumption (Hillson 1996), and that this has also been supported in the present study, it can be suggested that this dietary factor has not been the cause of the variations detected between subgoups within the ancient assemblage. This suggestion is reinforced by the fact that the difference in the prevalence of gingivitis and periodontitis between the ancient and modern population was relatively small. Therefore, the underlying reasons for such variations should be sought elsewhere.

Firstly, it should be noted that the difference observed between the sexes in the high SES group, that is males being more severely affected by periodontal disease, was an expected finding. This is because periodontal disease is regularly reported to be more prevalent in males than females at comparable ages (Albandar 2008). Males exhibit poorer oral hygiene than females, but even when corrected for oral hygiene, socioeconomic status, and other behavioural, social, and environmental factors, the male sex is still associated with more periodontal disease (Grossi 1994; 1995). It has been suggested that it is the effect of hormones, particularly the female hormone oestrogen, which protects against destructive periodontal bone loss (Genco 2000, 15). Moreover, the longer lifespan of male individuals in this subgroup may have also played a role, though a lesser one, in this outcome.

Thus, whilst the higher incidence of periodontitis in the high SES group can be attributed to the general tendency of males to be at greater risk due to biological factors, the severer affliction of females in the low SES group appears to be the result of underlying social parameters. The same appears to be the case for low SES individuals (females and male together), who were seven and two and a half times more frequently affected than their high SES counterparts, respectively. Considering all the above-mentioned results and combining them with the literary evidence that both females and people from the lower social classes were discriminated against and had different socioecomic roles in society than males and upper class individuals, it seems logical to assume that social status possibly played an important part in the periodontitis variation. Social hierarchy thus indirectly influenced some of the predisposing factors to periodontal disease and these were most likely related to immune response, systemic disease, and nutrition.

As has previously been mentioned, immune response plays a decisive role in the progression of periodontal disease. Nutrition is a critical determinant of immune responses and malnutrition the most common cause of immunodeficiency worldwide (Chandra 1997; 2002; 2004). Systemic diseases, especially those that compromise the host's ability to fend off infections, also often lead to more severe periodontal disease (Genco 2000). The blood cells have a vital role in supplying oxygen, haemostasis and protection to the tissues of the periodontium (Enhos *et al.* 2009). Systemic haematological disorders can thus have profound effects on periodontal health, by denying any of these functions necessary for the integrity of the periodontium (Kinane & Marshall 2001, 11). Reduced dietary calcium and iron intake, and vitamin C deficiency also increase the risk for periodontal disease (Genco 2000). Clinical studies have shown that oral tissues can be affected by pregnancy (Kaczmarek & Fita 2007). Pregnancy does not cause gingivitis or periodontitis, but may aggravate pre-existing disease, especially when preventive oral hygiene measures are not applied (Laine 2000). Ancient written sources suggest that all the above systemic diseases and nutritional deficiencies, as well as immunodeficiency, which predispose to periodontal disease, more frequently occurred, or were more likely to have occured, in the socially disadvantaged segments of the society, that is to say, individuals coming from the lower socioeconomic classes and women.

More specifically, literary evidence suggest that social divisions, reflecting sociocultural customs and attitudes, such as the different situations of men and women, revealed striking contrasts in many aspects of diet/nutrition, the general well-being, and mortality. Malnutrition and morbidity was possibly more widespread and more serious among women, especially those of child-bearing age, than among men (Garnsey 1999, 61). It has been pointed out, earlier in this chapter, that males were favoured over their female counterparts in the distribution of food, particularly of meat and other nourishing items. Meat, which is rich in iron and fruits, rich in vitamic C, for instance, were not staples and were thus possibly rarely consumed by the socially "inferior".

Some systemic diseases were also likely to be more common among women. For instance, acquired iron-deficiency anaemia is generally more common in females and this is the result of stresses and iron losses due to pregnancy, lactation and menstruation (Larsen 1997). It is to be associated with the impact of infection on body iron stores and is a pointer to nutritional stress. It must be emphasised that iron deficiency is part of the body's protective shield against infection (Ortner & Putschar 1981). Women under attack from disease and experiencing heavy blood loss, through natural causes and the commonly prescribed venesection, were particularly at risk in ancient Greece and elsewhere (Garnsey 1999, 28; Stravopodi *et al.* 2009; Triantafyllou 2001).

Limited knowledge on diet and nutrition could have also had an impact on women's health. For instance, a pregnant or lactating woman requires more than twice as much calcium as a man, and moderately active woman about three times as much iron (Garnsey 1999, 21). Calcium deficiency in pregnancy appears in cases of dietary inadequacy and in individuals who are unable to eat a diet rich in dairy products and has been associated with hypertensive disorders. Iron deficiency resulting mainly from poor dietary iron bioavailability causes anaemia and has been associated with maternal mortality. It is also known to affect the immune status. Thus, iron and calcium are important for maintaining maternal health and reducing the risk of infection (Ladipo 2000). Such facts were not known then, therefore, apart from social discrimination, lack of medical knowledge was also part of the problem.

Moreover, although disease was a social leveller, diet and the energy demands of work would have discriminated against the poorer, labouring classes. Thus, after the peak period of mortality was passed, members of the upper classes might be expected to achieve better health than their social inferiors, because of their superior diet and lower workload (Garnsey 1999, 49). A very characteristic example of inferior diet for the lower classes, apart from low meat and fish protein intake, is that of the high consumption of unleavened breads made with a high bran content, which is associated with various serious pathological conditions, such as iron-deficiency anaemia and rickets. The reason is the presence of phytate acid in cereals, especially in the bran and the germ, which impedes the absorption of vital minerals such as iron and calcium (Garnsey 1999, 20). The poorer one was, the less good-quality flour one could buy, and the less efficiently that flour was sieved (Wilkins & Hill 2006). Flour inefficiently sieved would have a high phytate content; and the higher the phytate content, the more deprived of vital minerals the body was likely to be (Garnsey 1999, 21). Thus, one might expect serious health problems in the lower socioeconomic classes to the extent that flatcakes and so on made from high-extraction, under-sieved flour (Dalby 2003), without leavening, were consumed in quantity, and especially where not much else was eaten.

All the above would have impaired general health and could thus have an impact on periodontal health. Therefore, the latter could provide evidence for the former, that is to say that periodontal health may reflect, to some extent, the general health status of a population. It is also interesting to note that males (regardless of SES), high SES males, and the high SES group (regardless of sex) reached an older age than females (regardless of SES), high SES females, and the low SES group (regardless of sex), respectively. This, along with all the above-discussed issues on the aetiology of periodontitis, enhances the notion that the groups that represent the advantaged segments of the society were indeed privileged in some ways, possibly in terms of nutrition, general well-being, and living conditions that apparently resulted in an enhanced immune system and a longer lifespan.

6.3.2.2 Athens

6.3.2.2.1 Key findings

Between sexes

- Overall, gingivitis affected more male interseptal areas (37.8%) more frequently than female (28.0%) but more female individuals (26.5%) than male (21.4%). Periodontitis was more common in female interseptal areas (64.1%) than male (58.7%), but more male individuals (78.6%) than female (71.4%).
- When the sexes were compared in each age group category separately, males displayed higher frequencies of gingivitis in all age groups and periodontitis only in the young age group; females were more frequently affected by periodontitis in the second and third age classes.
- Gingivitis rates declined in the middle adult category and then again rose in the older age category. The overall frequency of periodontitis increased from the first to the second age group but decreased from the second to the third, in both sexes.
- When comparisons between the two sexes were made for each category, gingivitis, quiescent phase and progressive periodontitis were more common in males, whereas only the acute phase of periodontitis rates were higher for females.

- In the female sample, mandibular interseptal areas were equally susceptible to gingivitis but more susceptible to periodontitis, compared to maxillary areas. In the male sample, mandibular interseptal areas were slightly more susceptible to gingivitis but less susceptible to periodontitis.
- Gingivitis affected posterior interseptal areas more frequently than anterior areas, whereas the opposite was the case for periodontitis, in both sex samples.
- The distribution of lesions on the left and right sides of the dentition was very similar for both sexes.

<u>Between SES groups</u>

- Overall, gingivitis affected both low SES interseptal areas (44.3% for low SES and 36.4% for high SES) and individuals (21.1% for low SES and 18.8% for high SES) more frequently. The opposite was the case for periodontitis, which was more common in high SES interseptal areas (52.9% for low SES and 62.5% for high SES) and individuals (18.8% for low SES and 81.3% for high SES).
- When the SES samples were compared in each age category separately, the low SES group exhibited higher rates in the first age class but considerably lower rates in the second and third age classes, whereas the exact opposite was the case for periodontitis.
- Gingivitis overall frequency steadily decreased with age, in both SES groups. On the contrary, periodontitis rates steadily increased with age, in both the low and the high SES group.

- When comparisons between the two SES samples were made for each category, gingivitis and quiescent phase periodontitis rates were higher in the low SES sample, whereas acute phase and progressive periodontitis were more common in the high SES group.
- Mandibular interseptal areas were more susceptible to gingivitis but less susceptible to periodontitis, in both SES samples.
- Gingivitis affected the posterior interseptal areas more frequently than the anterior, in both SES groups.
- The distribution of lesions on the left and right sides of the dentition was very similar for both SES groups.

6.3.2.2.2 Discussion

In the modern population, the distribution of gingivitis and periodontitis was quite different from that observed in the ancient population. The percentage of interseptal areas affected was slightly higher for females but more male individuals were affected; furthermore, males were more severely affected. These differences were not marked in terms of percentages. Overall, males appear to have been slightly more severely affected than females (χ^2=37.978 p=0.000). The differences between sexes, within SES groups were not taken into account because the samples for female individuals were extremely small (13 interseptal areas for low SES and 1 for high SES females) and were therefore not considered reliable.

High SES interseptal areas and individuals were more frequently than the low SES areas and individuals. The difference in the percentage of interseptal areas with signs of the condition was not marked, whereas the percentage of high SES individuals with periodontitis was much larger (more than four times) than that of low SES individuals. Thus, while fewer low SES individuals suffered from periodontitis, when they were affected it was more extensive and pervasive. Yet again, comparisons between SES groups within the female sex subgroup were not taken into account because the female samples were extremely small; therefore, the comparison between low and high SES groups is essentially a comparison between low and high SES males.

In brief, males were more severely affected than females and the high SES group experienced periodontitis more frequently but suffered a lower prevalence by individual. The difference between the sexes, though not marked, can be attributed to the biological tendency of males to be more severly afflicted by periodontal disease than females, most likely due to hormonal effects (Albandar 2008; Genco 2000). The less frequent (overall in the sample) but more severe and extensive affliction of low SES individuals points at a weaker immune response.

6.4 Dental Defects of Enamel

6.4.1 Comparison between populations, and among sex and socioeconomic status groups in Demetrias

The inter-population variation in enamel defects is expected to indicate that growth disruption levels are greater in the archaeological assemblage, because of better nutrition, particularly higher protein consumption by infants, higher maternal nutritional status, and advanced medical knoweledge and care in modern societies. Regarding sex differences, although there is a general tendency for males to be at greater risk of physiological disruption due to their genetic structure, social factors, namely preferential treatment of male infants/children are expected to have resulted in greater levels of physiological disruption for females, in both populations. Finally, if an association between treatment in death / occupation and social status is found, then physiological disruption is expected to be greater in the low status group due worse living conditions, food shortages, malnutrition, and greater exposure to infectious disease.

6.4.1.1 Key findings

Between populations

- The overall (regardless of defect type and tooth region) frequency rates of dental enamel defects (DDE) was higher for the ancient population (32.9% of teeth), compared to the modern one (21.9% of teeth). Furthermore, more individuals from the archaeological sample were affected (54.4%) than from the contemporary sample (44.3%).
- When age-groups were considered separately, frequencies were higher for Demetrias in the first two age classes and for Athens in the third age class.
- While in Athens, the overall rates steadily increased with age, in Demetrias, the frequency slightly increased from the young to the middle adult group but markedly decreased in the older adults.
- The most frequently affected tooth region was the cervical area, followed by the contact area and the occlusal region, in both assemblages. The difference between the first two areas was very slight.

- The most common type of defect was furrow-like defects, in both populations. In the archaeological assemblage, furrow-like defects were thirty times more common than pitted defects, whereas in the modern assemblage, they were fifteen times more common than pitted defects. Therefore, furrow-like defects are of much greater importance for the present study than bands of pitted defects. Plane-form defects were not observed in either of the populations.

- When comparisons between populations were made for each age group separately, furrow-like defects were more common in Demetrias in the young and middle adults and in Athens in older adults. Pitted defects were more frequent in the younger individuals from Demetrias and in the middle and older individuals from Athens.

- Furrow-like defects in the occlusal region were more frequently observed in the modern assemblage, whereas contact- and cervical-area furrow-like defects were more often present in the Demetrias assemblage. The latter two differences were marked.

- Bands of pitted defects in the occlusal region and cervical area were more commonly recorded in the modern population, wheras the opposite was the case for the contact area. The differences were small.

- In Demetrias, furrow-like defects were more regularly found in canines on all three areas, i.e. occlusal, contact and cervical, of the tooth. In Athens, the defects were more frequently observed in first incisors on all areas.

- Furrow-like defects were more regularly observed in the lower dentitions, whereas bands of pitted defects more commonly afflicted the maxillary teeth, in both populations.

Between sexes

- The overall (regardless of defect type and tooth region) frequency rates of dental enamel defects (DDE) in Demetrias was higher for females (34.5% of teeth), than for males (32.0% of teeth). However, more male individuals were affected (59.1%) by the condition than females (45.9%).
- When age-groups were considered separately, frequencies were higher for males in the first and third age classes but markedly higher for females in the second age class.
- While in females, the overall rates increased from the first to the second age group and markedly decreased in the third, in males, the frequency steadily decreased with age.
- The most frequently affected tooth region for females was the cervical area, followed by the contact area and the occlusal region, and for males the contact area followed by the cervical area and the occlusal region. The difference between the sexes in the contact area was very slight, whereas the occlusal region was equally affected in both sexes.
- The most common type of defect was by far furrow-like defects, in both sexes. In the female sample, furrow-like defects were twenty-seven times more common than pitted defects, whereas in the male assemblage, they were twenty-nine times more common than pitted defects. Plane-form defects were not observed in either of the populations.
- When comparisons between the sexes were made for each age group separately, furrow-like defects were more common in females in middle adults and in males in young and older adults. Pit defects were more frequent in the younger individuals from the female sample and in the middle

individuals from the male sample. Older individuals were not affected by pit defects in either sex group.

- Furrow-like defects in the contact area equally affected the two sexes, whereas cervical-area furrow-like defects were more common in females.
- Bands of pitted defects in the occlusal region equally affected the sexes. Contact area pits were more commonly recorded in females, wheras the opposite was the case for the cervical area. The differences however, were quite small.
- In females, furrow-like defects were more regularly found in first incisors on both the contact area and the cervical region. In males, the defects were more frequently observed in canines on both areas.
- Furrow-like defects were more regularly observed in the lower dentitions, whereas bands of pitted defects more commonly afflicted the maxillary teeth, in both sexes.

<u>Between SES groups</u>

- The overall (regardless of defect type and tooth region) frequency rates of dental enamel defects (DDE) in Demetrias was markedly higher for the low SES group (56.1% of teeth), than for the high SES group (19.9% of teeth). Furthermore, a considerably higher percentage of low SES individuals were affected (77.5%) by the condition than high SES individuals (39.7%).
- When age-classes were considered separately, frequencies were higher for the low SES group in all three of them.

- In both SES groups, the frequency rates of DDE steadily decreased with age; the difference was more pronounced between the middle and the older adults.

- The most frequently afflicted tooth region was the cervical area, followed by the contact area and the occlusal region for both SES samples. The difference between the SES groups was very marked in the cervical and the contact area, whereas both the low and the high SES group were equally affected in the occlusal region.

- The most common type of defect was by far furrow-like defects, in both SES assemblages. In the low SES sample, furrow-like defects were more than forty-one times more common than pitted defects, whereas in the high SES assemblage, they were almost twenty times more common than pitted defects. Plane-form defects were not observed in either of the populations.

- When comparisons between the SES samples were made for each age group separately, furrow-like defects were more common in the low SES group, in all age classes. Bands of pitted defects were more frequent in young adults from the low SES sample and in the middle adults from the high SES sample. Older individuals were not affected by pit defects in either SES group.

- Furrow-like defects in the contact and cervical area were much more commonly observed in the teeth of the high SES individuals. No occlusal furrow-like defects were recorded.

- Bands of pitted defects in the occlusal region equally affected the SES groups. Contact area pits were more commonly recorded in the high SES group, whereas the opposite was the case for the cervical area. The differences however, were quite small.

- Furrow-like defects were more regularly found in the canines of both SES groups.
- Both furrow-like and bands of pitted defects were more regularly observed in the upper dentitions of the low SES group and in the lower dentition of the high SES group.

6.4.1.2 Discussion

To summarise:

- the frequency of DDE was higher in the ancient population
- males have a lower percentage of teeth with DDE, although more male individual displayed defects
- within the low SES subgroup however, females were more commonly affected than males and, within the high SES subgroup, males were more frequently affected than females

Population analysis using dental enamel defects as health-indicators is based on the assumption that differences in the frequency of the condition reflects differences in the stress levels of a population. However, there is a significant problem with the interpretation of the results given by such analysis; in fact, there are two totally different interpretations. The high frequency and severity of DDE may indicate greater exposure to malnutrition and stress, that is to say the more frequent the defects, the greater was the stress experienced during their childhood, thus the less favourable life conditions the population had (Goodman et al. 1980; Littleton 2005; Wood 1996). Or, alternatively, the presence of stress markers could mean that the individual managed to get through the disease and recovered, so, his / her living conditions or individual resistance must have been better than those who had died in childhood and thereby do not show any traces of stress on their teeth (Arcini 1999; Wood *et al.* 2002). In order determine whether the first or the second is the case, the results for the archaeological population and the relationship between developmental stress and longevity are discussed first. The rationale behind this is that, in the modern population, there is no actual association between age-at-death and DDE prevalence; that is to say that longevity in modern populations is attributable to medical advances and therefore, mortality cannot be considered, to a large extent, the result of childhood stress.

According to the data derived from the archaeological assemblage, there are four indications that, taken together, are in support of the first theory and, according to it, suggest that the higher the frequency of DDE the greater was the stress suffered during childhood: (a) the age-at-death of individuals without enamel defects was higher than that of individuals with enamel defects, in most sub-groups within populations (e.g. low SES females) (b) most sub-populations (e.g. high SES group) with lower DDE frequency rates had higher age-at-death than those with more defects, (c) the sub-population with the highest DDE frequency of all, i.e. the low SES females, lived a shorter life than both low SES males and high SES females, and (d) the low SES group had a markedly higher percentage of both individuals and teeth with defects than the high SES group. Of course, if any one of the above indications is considered independently, the association between impoverished conditions and disrupted enamel formation will not be as strongly supported. Moreover, there is skepticism regarding issues such as the association between childhood stress and decreased longevity, and between enamel defects and sex as well as socioeconomic status. It is therefore important to discuss these points in question.

Based on the theory that events leading to physiological stress in early childhood can have a major effect on adult morbidity and mortality (Humphrey & King 2000; van den Berg *et al.* 2009), several studies have investigated the relationship between developmental stress and longevity. Some of them observed marked differences in the DDE prevalence between those who died during childhood and those who survived into adulthood (Slaus 2000), whereas others did not (Malville 1997). The same comparison but between adult sub-groups, in relation to age-at-death, has also been made (Boldsen 2006; Palubeckaite *et al.* 2002). Alternatively, the relationship between developmental defects and longevity can be explored by comparing the mean age-at-death of adults with and without enamel defects (Goodman & Armelagos 1988).

The number of surviving subadult teeth from Demetrias was negligible, partly due to recovery, preservation and conservation reasons, but also because most subadult individuals were apparently buried outside the cemetery (Golden 1988), and only a small number of them was recovered during the excavation of the cemetery. Thus, subadults were excluded from the study and consequently, comparisons between subadults and adults were not possible. However, when comparisons between the age-at-death of individuals with and without enamel defects were made, it was revealed that a higher percentage of the former died in the young age group (except for high SES males) and a larger proportion of the latter reached a higher age. This was the case in all subgroups, except for one. More specifically, low SES males, high SES females, and high SES males not affected by DDE lived longer than their affected counterparts, whereas it was only in the low SES female sample, that no difference in the age-at-death of affected and not affected individuals was observed.

Moreover, fewer of the low SES individuals reached the older adult age-group, compared to the high SES individuals, who displayed a higher frequency of DDE. Thus, 24.0% of high SES individuals (22.2% of the high SES females and 25.0% of the high SES males) reached age 50+ years, whereas none (0.0%) of the low SES individuals lived up to that age. The lifespan of the most frequently affected sub-sample of all, i.e. the low SES females, was shorter than that of low SES males, high SES females, and high SES males. More specifically, 50.0% of the low SES females died in the young age group as opposed to 20.0% of the low SES males; also, all of the low SES females had died before reaching the older age group, whereas 22.2% and 25.0% of the high SES females and high SES males, respectively, reached age 50+ years.

Males, of both low and high SES, reached a higher age-at-death than their female counterparts, who displayed higher rates of DDE in the low SES group but lower rates in the high SES group. By age 20-35 years 50.0% of low and 55.6% of high SES females had died, compared to only 20.0% of low and 25.0% of high SES males, respectively. In other words, in the low SES group, individuals with more defects (i.e. females) had higher risk of dying young (20-35 years) and also had a shorter lifespan than those (i.e. males) who displayed lower DDE rates, whereas in the high SES group, individuals with more defects (i.e. males) lived longer. Although these two outcomes seem contradictory, there is a plausible explanation. As in many pre-industrial societies, females experienced a higher risk of dying at a young age, and also have a shorter lifespan, than males. This female elevated rate of mortality "was related to reproduction, that is to say that death during childbirth and due to reproductively-related wear and tear on the women" (Boldsen 2006, 6; Doblhammer 2000). This means that male adult age mortality is much more a continuation of adolescent mortality than is female adult mortality. Because of this, the mortality effects of DDE are more clearly seen among men than among women (Boldsen 2006). Therefore, in the case of the female subset of the archaeological population under study, there is probably no actual association between early mortality rates and age-at-death, and DDE prevalence; that is to say that mortality in early adulthood and even later on in life was not the result of childhood stress, at least not exclusively, but rather of childbirth and reproductivity-related wear and tear (Doblhammer 2000). This is also confirmed by the fact that peak female mortality was in the young age-group, with 50.0% of all low SES and 55.6% of all high SES adult females dying between 20-35 years. Consequently, the fact that females of the high SES sample displayed lower rates of DDE than their low SES male counteparts but died younger than them does not necessarily mean that the former suffered greater levels of childhood stress than the latter. This is because, in this case, there is no clear association between childhood stress and adult mortality. The possibility of childhood stress contributing to a higher female mortality should not be excluded of course, especially in older age group (in which childbirth does not have a direct impact), but cannot be supported either.

Taking into account all the above, the association found between the frequency of DDE and the risk of dying later on in adulthood strongly suggests that those individuals displaying stress indicators represent those that experienced greater stress in childhood. And, although the individuals with the highest rates of defect had an immune response strong enough to allow them to survive into adulthood, they died at a younger age than those with lower rates of defects. Besides, DDE are non-specific stress indicators of multifactorial origin, associated with diseases that vary in severity and duration, and are not all equally life-threatening or may not be life-threatening at all (Brook 2009; Griffin & Donlon 2009); they may, however, have an impact on the morbidity and mortality of the individual later on in his/her life (Smith *et al.* 1998). As

Goodman and Armelagos (1988) have proposed, there are at least three processes that may account for the association between childhood stress and decreased life expectancy: (1) inherent biological susceptibility, (2) biological damage, and (3) lifelong differential cultural buffering (Duray 1996; Goodman & Armelagos 1988; Humphrey & King 2000; King *et al.* 2005). According to the first one, "individuals who are ill during childhood continue to fall ill as adults. This association is due to a weaker "constitution", and the sum effect is earlier death" (Goodman & Armelagos 1988, 941; King *et al.* 2005, 556). The second hypothesis suggests that "individuals who were exposed to and survived a period of severe childhood stress may suffer a loss in ability to respond to other stresses" (Goodman & Armelagos 1988, 941; King *et al.* 2005, 556). The third biocultural hypothesis points toward "differential lifelong patterns of behaviourally and culturally based exposure to stressors" and suggests that this association between childhood stress and decreased adults longevity "is mainly due to social conditions present in childhood, which are likely to persist into adult life" (Goodman & Armelagos 1988, 942; King *et al.* 2005, 556).

While it is not possible to rule out any of these processes, as they all may contribute to the association between childhood stress and longevity, it is legitimate to say that the latter hypothesis is consistent with the archaeological evidence. Since, according to it, lifelong differences in social status, and consequently differential cultural buffering from stress, are significant, it is of great importance to assess cultural buffering by inferring social status through archaeological data. For this reason, comparisons between individuals coming from burials with grave goods and individuals that were buried without any grave goods were made. These had the purpose of ascertaining whether status differences explain the association between childhood stress and longevity.

Grave offerings have often been considered a non-reliable relative social status indicator (Goodman & Armelagos 1988; Parker-Pearson 1999). In the present study, it had been assumed that no differences were going to be found between burials with and without grave goods for several reasons discussed in *Hypotheses* (*Chapter 2*). Nevertheless, as has previously been mentioned, marked differences were revealed, with the low SES teeth almost three times more frequently affected than high SES teeth (χ^2=171.751 p=0.000) and low SES individuals were almost twice as much afflicted as their high SES counterparts. This variation was observed in all age classes, which makes the outcome even more reliable. Furthermore, when comparisons were made for furrow-like defects in the anterior teeth (incisors and canines), that is for the most common type of defect in the most regularly affected tooth types, in order to avoid bias, the differences between SES groups and SES groups among females and males, were very similar.

In conclusion, there are two pieces of evidence that are of importance here: (a) the variation observed between low and high SES status, as this is defined by the absence and presence of grave goods, in the prevalence of DDE and (b) the higher age-at-death of the high SES individuals, compared to low SES individuals. This relationship between grave-goods / socioeconomic status and DDE explains the association between DDE and age-at-death and confirms the third mechanism proposed by Goodman and Armelagos (1988). However, the fact that the "lifelong differential cultural buffering" hypothesis is in accord with archaeological evidence, does not mean that the cultural explanation is exclusive of the "biological damage" mechanism. Low socioeconomic status during childhood "may promote undernutrition and disease, which leaves individuals less rally from future insults" (Goodman and Armelagos 1988, 942).

The interpretation of differences in the prevalence of DDE between the sexes is extremely complicated (Wood *et al.* 1992). There are both subadult and adult studies, which have reported higher prevalence of DDE in the females (Goodman *et al.* 1987; Griffin & Donlon 2009; King *et al.* 2005; Slaus 2000), whereas other studies found a higher prevalence in males (Li *et al.* 1995; Palubeckaite *et al.* 2002; Saunders & Keenleyside 1999). Males and females may differ in vulnerability to environmental stress or their teeth may record insults differently (King *et al.* 2005), and they may be exposed to different levels of stress as a result of cultural preference for female, or, in most cases, for male children (Guatelli-Steinberg & Lukacs 1999; King *et al.* 2005). Depending on the severity of the stress, the extent to which the individual is exposed to this stress and the susceptibility of the individual to DDE formation, the individual may not experience growth disruption, or may succumb to the stressor and die (Griffin & Donlon 2009). The susceptibility of the individual exposed to the stress may be due to biological or/and cultural factors that are defined by sex/gender. Thus, researchers, who find higher rates of DDE in male individuals, explain this trend as a consequence of genetic difference between the sexes and have suggested that males are biologically more sensitive to stress than females, due to their genetic structure (El-Najjar *et al.* 1978; Van Gerven *et al.* 1990), although the theory of increased female buffering remains ambiguous (Guatelli-Steinberg & Lukacs 1999). Other researchers, who find greater prevalence in females, argue that this is the result of male children being better protected culturally from stress than female children (King *et al.* 2005; Slaus 2000). The fact that most studies that have shown statistically significant sex differences in DDE involve higher frequencies in males may suggest that there could be a slight effect of male vulnerability on the expression of enamel defects (Guatelli-Steinberg & Lukacs 1999).

In the present study, overall, regardless of age, DDE type and tooth region, more female teeth displayed signs of DDE (χ^2=0.822 p=0.365) but more male individuals were affected by the defects. When the sexes were compared within each SES group separately, the percentage of male individuals was still higher in both low (χ^2=6.336 p=0.012) and high SES samples (χ^2=0.377 p=0.539); however, the sample sizes, especially that of females were quite small and most possibly, biased. On the other hand, the frequencies for furrow-like and bands of pitted defects per tooth revealed that, although in the high SES groups males had a slightly higher proportion of hypoplastic (furrow-like defects) teeth (12.5%) than females (10.2%), in the low SES group, female teeth were markedly more often affected by furrow-like defects (42.0%) than male teeth (34.9%). Furthermore, low SES females also had a higher proportion of teeth with bands of pitted defects (1.2%) than low SES males (0.7%); the sexes in the high SES sample were equally affected by pit defects (0.6%). Comparisons were also made for the incisors and canines only, as they are the most frequently affected tooth types, in order to avoid bias, and it was again revealed that in the high SES sample, the total percentage for anterior teeth was higher for males (21.5%) than females (17.5%), but, in the low SES sample, the opposite was the case, with female anterior teeth displaying higher DDE rates (55.2%) than male anterior teeth (53.7%). Although the percentage differences observed between the sexes were not great, chi-square tests showed that the relationship between the presence of DDE and sex was statistically significant in the low SES group (χ^2 =6.336, p=0.012), whereas, in the high SES sample, it was not (χ^2 =0.377, p=0.539). Moreover, the trend of females to have a higher proportion of hypoplastic teeth is interesting as it was unexpected, given the greater physiological sensitivity of males to environmental perturbation.

This variation may be the result of cultural practices with a strong impact on sex differences in the prevalence of hypoplastic defects, which override the potential effect of greater male vulnerability to environmental stress (Goodman *et al.* 1987). In many regions of the world, even today, parents exhibit a preference for sons over daughters and act on this bias. Such behaviour may include direct female infanticide, the neglect or abandonment of daughters, and differential allocation of resources towards sons (Feldman & Laland 1996). King *et al.* 2005 more specifically point toward "different nursing practices, inequality in access to suitable food and medical resources, and different bahavioural expectation, perhaps resulting in reduced exposure to sunlight in girls" (King *et al.* 2005, 557). The aggregate effect of these activities may generate a trend towards increased frequencies of enamel defects in females compared to males.

Literary evidence for ancient Greece suggests that boys were favoured over girls, although there is no direct information regarding, for instance, differential breast-feeding practices between female and male infants. Favourable treatment of male infants and children may have manifested itself in different ways. One of them was preferential female exposure or infanticide (Engels 1980; Golden 1988; Harris 1982; Patterson 1985; Pomeroy 1993; Rousselle 2001). There are specific references in inscribed laws or contracts, and also recommendations by Aristotle and Plato for exposing or not rearing infants in certain situations (Patterson 1985, 111-112), which suggest that the often fatal exposure of newborns was widespread throughout Greek history. Archaeological evidence, consisting of a series of Milesian inscriptions, supports the probability of an unspecified high rate of female infanticide in the Hellenistic period (Pomeroy 1993). There are several factors underlying preference for male offspring. Self-evidently, people are most likely to begin practicing and tolerating fatal child exposure when they think that too many children are being born, or too many of one sex (Harris 1982, 115). This might well be one of the possible causes of preferential female exposure in ancient Greece, due to the higher life expectancy of females; however, other cultural parameters, such as the burden of providing dowries, the reliance on one's sons' support in old age, or the wish to ensure the continuation of ancestral lineage through the male line, as well as the fact that males made up the main part of the productive workforce, could have played an important role (Garnsey 1999).

Whatever its causes, the practice of preferential female exposure, although it does not in and of itself constitute evidence of a favourable treatment of male infants/children in terms of care and nutrition, certainly denotes a preference towards them. In a society where preference is given to the sons, preferential treatment of boys would have undoubtely affected girls and would have resulted in greater physiological stress for the latter. There might have been "a subtle, perhaps unthinking favouring of the male child in its physical care and nourishment" (Patterson 1985). Especially under marginal conditions, such as food shortages, which were common in Hellenistic Thessaly (Garnsey 1988), this preference would have had an impact on the childcare of female children and the division of food between the sexes (Faerman & Smith 2008). Such an example exists in Veleia, Italy, where, in times of food shortage, the extreme ratio between the sexes of children found in private alimentary schemes shows that the girls were exposed or neglected or both (Garnsey 1988). Moreover, the inferior status of (adult) females in society and the family, and the sex bias in the family allocation of food may also be considered indications that differential treatment in favour of male children was also a fact.

The results of the present study therefore suggest the possibility that male infants/children of low SES may have been obtaining greater access to basic resources such as food and care than their female counterparts. This, however, does not appear to be the case for the high SES infants/children, given that in the high SES group, males had more hypoplastic teeth than females. This does not necessarily mean that cultural beliefs differ in the upper classes and that higher status females were not discriminated against, but rather that there was no practical need for differential treatment of female infants/children. That is to say that price fluctuations and food shortages did not have an impact on the well-off families, at least not as great as on the economically disadvantaged, because there were potential mechanisms that helped them cope with subsistence crises. In any given crisis, not all of the members of the society will be equally at risk. The level of vulnerability will vary from person to person based upon such factors as occupation, wealth, amount of land, political connections, and family size; collectively, these factors establish individuals' entitlement to food supplies during a crisis (Gallant 1989, 395). The study of Thessaly has indicated that approximately 30 to 50% of a previous season's bumper wheat crop was still in the hands of the primary producers the following spring, the time of year that is typically associated with scarcity (Garnsey *et al.* 1984). Thus, in a region such as Thessaly, which experienced regular fluctuations in food supply, and where entitlement of food was established through ownership of or access to land, the disadvantaged segments and members of the society were those more severely affected by subsistence crises. Therefore, if the well-off families had enough food for all their members, there was no reason not to feed female and male children equally.

All the above could also explain the differences found in DDE prevalence between upper and lower SES in the archaeological assemblage. The relationship between socioeconomic status and the frequency and severity of DDE is still debatable and open to discussion. There are studies that confirm such a relationship (King *et al.* 2005; Palubeckaite *et al.* 2002; Robb *et al.* 2001; Rugg-Gunn *et al.* 1997; van den Berg *et al.* 2009), but there are also contradictory results that do not show a correlation between DDE and socioeconomic status (Elley & Charlton 1993). In the present study however, there seems to be an important relationship between the prevalence of enamel defects and SES. Low SES individuals had almost three times as many hypoplastic teeth as their high SES counterparts (χ^2=171.751 p=0.000), and almost twice as many low SES individuals were affected by enamel defects. The low SES sample showed a higher prevalence of DDE in all three age groups, and all tooth regions; also, both furrow-like and pitted defects were more common in the low SES sample. Comparisons within sex groups revealed marked differences in both sexes; in the female assemblage, DDE was recorded in 64.0% of the low SES as opposed to only 18.8% of the high SES teeth, and in the male assemblage, DDE was observed in 51.7% of the low SES as opposed to 20.6% of the high SES teeth. The difference was more pronounced in females (3.4 times) than in males (2.5 times). Moreover, these differences were found to be highly significant both for females (χ^2 =94.921, p=0.000) and for males (χ^2 =82.342, p=0.000). The results for the anterior teeth only, again revealed large differences between the two SES groups; in the female sample, DDE was recorded in 55.2% of the low and 17.5% of the high SES teeth, and, in the male sample, they were observed in 58.9% of the low and 21.5% of the high SES teeth. The difference was more pronounced in females (3.1 times) than in males (2.7 times).

As has already been noted, these differences between SES groups may well be the result of food shortages, which had a greater impact on the lower socioeconomic classes, but this might not have been the only explanation. High

SES families would have afforded less crowding space and less unsanitary conditions and would have also been better protected by the effects of severe weather in the winter (Cox 1996, King *et al.* 2005). Moreover, women of the upper classes would have been healthier and better nourished than their poorer counterparts, and that would consequently have positively influenced their children's health, both before birth (during pregnancy) and during breastfeeding (Raiten *et al.* 2007). In addition, whenever food was scarce, maternal feeding would have been the only nutritional source for infants in the low SES households; if maternal feeding as the only nutritional source is prolonged over six months, however, this would result in a protein and calorie deficiency (Lovell & Whyte 1999; Raiten *et al.* 2007). The well-off family also had an advantage at the weaning stage because it had access to a wider range of foodstuffs, including some that were good protein sources (Garnsey 1999, 107).

Comparisons between the Hellenistic and the modern population samples revealed important differences in the prevalence of DDE; the ancient population had a higher proportion of both individuals and teeth affected by defects. The difference in teeth affected was found to be highly significant statistically (χ^2 =,31.083 p=0.000). In view of these findings, discussion will concentrate on attempting to find any pre-eminent causes of enamel defects, despite its multifactorial aetiology, which might provide clues as to why there was a higher prevalence of DDE in the archaeological assemblage. The differences in the expression of DDE between the ancient and the modern population, suggest that the risks resulting from the parameters affecting DDE prevalence differed between the two sites. The higher frequency of DDE in the archaeological population can be attributed to several factors, including: (a) differences in immune susceptibility, associated with breastfeeding practices, (b) weaning, (c) protein consumption, (d) maternal nutritional status (vitamic D intake and calcium concentration), and (e) access to medical care.

In the 20th century, most Greek women breastfed their children according to the advices of health professionals, who praised breastfeeding, stressed the importance of sanitary measures, and also gave guidance on weaning practices (Pechlivani *et al.* 2008). In ancient Greece on the other hand, the lack of medical knowledge on such matters as infant feeding practices most likely had a very negative impact on the health of infants. Literary sources suggest that “babies were frequently denied colostrum (protein-rich and protective against infections), were regularly given to a wet-nurse (although in principle mother’s milk is best), were standardly subjected to swaddling (which might contribute to bone deformation if coupled with confinement and a poor diet), were liable to be weaned dangerously early or dangerously late, and were weaned onto foods that were often nutritionally inadequate” (Garnsey 1999, 53). Thus, infants/children of the Hellenistic period were possibly more susceptible to disease, due to an impaired immune response, and malnutrition, both associated with lactation and weaning practices.

A variety of human studies suggests a relationship between enamel hypoplastic defects and protein-energy malnutrition, i.e. inadequate protein intake (Goodman *et al.* 1991; Moynihan 2005). As has already been mentioned earlier in this chapter, in antiquity, meat was a high-status food because animals were expensive to raise, and was thus rarely consumed by the majority of the population, even by individuals of high status, compared to modern standards. On the other hand, data for 20th century Greece, suggests that meat-protein alone represented 22-27% of the energy available prior World War II and in the 1950s, and 33-36% of the energy intake in the 1960's, and even higher in the following decades (Georgakis 2001; Matalas 2001). Prolonged lactation/nursing, which was most likely practiced in the ancient population, becomes inadequate to the increasing protein requirements of children over time (Blakey & Armelagos 1985). The weaning diet that followed (cereals) was also been protein poor. These conditions would have contributed to protracted malnutrition and immune susceptibility to disease (Blakey & Armelagos 1985). Therefore, a much lower protein consumption possibly contributed to a higher prevalence of enamel defects in the archaeological population.

Maternal nutritional status greatly influences foetal health, and the process by which essential nutrients are tranferred from mother to embryo in utero is of immense importance (Raiten *et al.* 2007). Mothers of modern, compared to ancient, populations are perhaps less likely to suffer from vitamin D and calcium deficiency, owing to a better nutrition (milk, dairy products, eggs, fish, meat) and vitamin D and calcium supplementation during pregnancy (Cockburn *et al.* 1980). On the other hand, in ancient populations, mothers' intake of vitamin D and calcium would have been very low, considering their cereal-based diet with the limited access to meat, fish, milk, and dairy products (Wilkins & Hill 2006). Taking into account that malnutrition in the mother often causes enamel defects to form prenatally and during lactation (Lovell and Whyte, 1999: 75), the higher DDE prevalence in Demetrias can be partly attributed to vitamin and calcium deficiency.

Medical advances of the 20th century might have also contributed to the lower DDE prevalence in the modern population. In modern populations, basic infection control measures can significantly reduce morbidity; sick, low birthweight, and premature infants are cared for in bassinets designed to keep them warm and limit their exposure to germs and are given medications that protect them from exposure to disease and prevent malnutrition (Antonucci *et al.* 2009). In pre-industrial populations, although a lower percentage of lowbirth, premature, and sick infants would have survived to be exposed to disease and develop enamel defects, those that did survive would have developed a weaker immune response to disease and possibly higher DDE frequencies.

6.4.2 Comparison among sex and socioeconomic status groups in Athens

6.4.2.1 Key findings

<u>Between sexes</u>

- The overall (regardless of defect type and tooth region) frequency rates of dental enamel defects (DDE) was higher for males (25.4% of teeth), than for females (17.4% of teeth). Furthermore, more male individuals were affected by the condition (52.6%) than females (34.7%).
- When age-groups were considered separately, frequencies were higher for males in the first and third age classes and for females in the second age class.
- While in males, the overall rates increased from the first to the second age group and markedly decreased in the third, in females, the frequency decreased from the young to the middle adult age-group and increased in the older age-group.
- The most frequently affected tooth region for both females and males was the cervical area, followed by the contact area and the occlusal region. The difference between the sexes in the cervical and the occlusal areas were marked.

- The most common type of defect was furrow-like defects, in both sexes. In the female sample, furrow-like defects were more than seven times more common than pitted defects, whereas in the male assemblage, they were thirty-five times more common than pitted defects. Plane-form defects were not observed in either of the populations.

- When comparisons between the sexes were made for each age group separately, furrow-like defects were more common in females in middle adults and in males in young and older adults. Pit defects were more frequent in the young and middle adults from the female sample and in the older individuals from the male sample.

- Furrow-like defects in the contact and cervical area affected males more frequently than females.

- Bands of pitted defects were more often recorded in females, in all tooth regions.

- In females, furrow-like defects were more regularly found in canines in both the contact area and the cervical region. In males, the defects were more frequently observed in first incisors in both tooth areas.

- Furrow-like defects were more regularly observed in the lower dentitions, whereas bands of pitted defects more commonly afflicted the maxillary teeth, in both sexes.

<u>Between SES groups</u>

- The overall (regardless of defect type and tooth region) frequency rates of dental enamel defects (DDE) was slightly higher for the high SES group (27.1% of teeth), than for the SES group (28.2% of teeth). However, a higher percentage of low SES individuals were affected (64.7%) by the condition than high SES individuals (50.0%).

- When age-classes were considered separately, frequencies were markedly higher for the low SES group in the first two but slightly lower in the third age group.
- In the low SES sample, the frequency rates of DDE decreased from the first to the second age group, whereas in the high SES sample, the frequency slightly increased from the first to the second age group; there were no teeth affected in the third age group.
- The most frequently afflicted tooth region for the low SES group was the cervical area, followed by the contact area, whereas the opposite was the case for the high SES group. The differences between the SES groups however, were small.
- The most common type of defect was by far furrow-like defects, in both SES assemblages. In the low SES sample, furrow-like defects were more than fourty-nine times more common than pitted defects, whereas in the high SES assemblage, they were twenty-two times more common than pitted defects. Plane-form defects were not observed in either of the populations.
- When comparisons between the SES samples were made for each age group separately, furrow-like defects were more common in the low SES group, in all age classes. Bands of pitted defects were more frequent in middle adults from the low SES sample and in the older adults from the high SES sample. Young individuals were not affected by pit defects in either SES group.
- Furrow-like defects in the contact area were more commonly observed in the teeth of the high SES individuals and furrow-like defects in the cervical region more commonly occured in the low SES teeth. The differences were

not marked, especially for the cervical region. No occlusal furrow-like defects were recorded.

- Bands of pitted defects did not affect the occlusal region in either SES group. Contact area pits were more commonly recorded in the low SES group, whereas the opposite was the case for the cervical area. The differences however, were quite small.
- Furrow-like defects were more regularly found in the first incisors of both SES groups.
- Both furrow-like and bands of pitted defects were more regularly observed in the lower dentition of the low SES group and in the upper dentition of the high SES group.

6.4.2.2 Discussion

In summary, in the modern population, males were more severely afflicted than females but the difference was small (χ^2=8.275 p=0.004), whereas the high SES group was slightly more commonly affected than the low SES group (χ^2=18.574 p=0.000).

Comparisons between the sexes in the modern population, revealed that more male individuals showed signs of enamel defects than female individuals. In addition, the proportion of teeth affected was markedly higher for the male sample. The relationship between presence of DDE and sex was statistically significant (χ^2 =8.275, p=0.002). Moreover, the frequencies of furrow-like defects in anterior teeth, showed that 31.2% of male and 19.1% of female teeth were affected. These differences point at greater male vulnerability. Son preference in

20th century Greece (Pashos 2000) would have possibly resulted in differential treatment of male children, in terms of nutrition and care. Therefore, the fact that males, although they were favoured, still exhibit higher DDE frequencies, means that they were more vulnerable to environmental stress (Guatelli-Steinberg & Lukacs 1999). When statistical analysis was carried out for each SES group separately, the relationship between DDE and sex was highly significant for the low SES only (χ^2 =16.649, p=0.000), whereas for the high SES group, it was not (χ^2 =1.209 p=0.272).

Differences between SES groups were considered for males only, because the female sample, especially that of high SES, was very small. Thus, 34.9% of the teeth from the low SES sample and 27.1% of the teeth from the high SES sample were hypoplastic. The relationship between DDE and SES within the male sub-group, however, was not statistically significant (χ^2 =4.491, p=0.213). Furrow-like defects were present in 42.6% of the low SES and 24.0% of the high SES anterior teeth. When statistical analysis was carried out for the anterior teeth only, the differences between SES groups, were not statistically significant in none of the three anterior tooth types (χ^2 =5.184, p=0.159 for first incisors, χ^2 =4.311, p=0.230 for second incisors, χ^2 =1.472, p=0.689 for canines). This trend, however, which is also observed in the archaeological population, can be attributed to differences in childhood stress levels between low and high status male children. Lower prevalence in high SES individuals can be associated with factors such as better nutrition (e.g. protein consumption, and vitamin D and calcium intake), superior breastfeeding and weaning practices, less crowding and unsanitary conditions, protection by the effects of severe weather, lesser exposure to infections, stronger immune response, access to medical care and medication, and better maternal health and nutritional status.

Chapter 7

CONCLUSIONS

This final chapter includes a summary of key findings and important discussion points, an evaluation of the hypotheses, concluding remarks related to the questions addressed, the limitations and difficulties of the present study, and thoughts and ideas about future potential and further research.

7.1 Hypotheses Evaluation, Key Findings and Inferences

7.1.1 Ancient versus modern oral pathology and wear patterns

The first set of hypotheses was that the 20th century population would exhibit higher frequencies of caries, antemortem tooth loss and periodontal disease, whereas the Hellenistic population would display heavier occlusal wear and greater susceptibility to physiological disruption during growth.

7.1.1.1 Dental caries and antemortem tooth loss

Consistent with other studies and as it was hypothesised, tooth decay and antemortem loss occurred significantly more often in the modern than the archaelogical assemblage; furthermore, carious lesions were markedly severer in the former. This variation was attributed to diet-related differences between pre-industrial and industrial populations, namely, food texture (Keenleyside 2008) in association with food technology, i.e. processing and preparation (Curtis 2008), different kinds of carbohydrates in each diet (Garnsey 1999; Hillson 2008; Matalas 2001), and dietary habits (Llena & Forner 2008).

Food processing and cooking is considered the most important of these factors because the glycaemic response plays a very important role in caries initiation and development (Lingstrom *et al.* 2000a), as it is associated with changes in the pH environment of plaque deposits (Hillson 2008). Thus, whereas modern, factory-processing methods dramatically affect the blood glucose profile of foods, ancient processing and conventional cooking methods, would have produced the lowest possible glycaemic response (Curtis 2008). In addition, the exposure of plaque bacteria to sugars is strongly influenced by consumption frequency and retentiveness. Thus, eating more than three times per day in modern societies (Lingstrom *et al*. 2000), especially high-sugar/high-starch meals or snacks, is considered to be a highly cariogenic habit (Van Houte 2000). On the other hand, ancient populations that consumed primarily "pure" starchy foods with very few sugars, did so only during two or three meals per day, and this is also attested for ancient Greece (Garnsey 1999; Wilkins & Hill 2006).

7.1.1.2 Occlusal wear

With regard to occlusal wear, the results verify the hypothesis, and very clearly reflect the differences in subsistence between populations, as the archaeological assemblage showed much heavier wear. Considering that tough diets produce heavy wear at rapid rates (Gamza & Irish 2010), this variation is evidently associated with the fact that Hellenistic people's diet was based on coarse, abrasive, often uncooked and, predominantly, unrefined food (Keenleyside 2008), whereas modern populations' diet is based on soft, factory-processed, and cooked food items (Teaford & Lytle 1996). The finding that the ancient sample showed heavier wear in the posterior teeth, while in the modern sample it was the anterior teeth exhibiting the greatest wear, is possibly the result of the prominent role of different factors other than food mastication in industrial populations. In ancient agricultural populations, food consumption played the most prominent role in wear rates and patterns, since the foods consumed were tough and abrasive. In contrast, in modern populations, wear rates and patterns are largely determined by parafunctions, mainly bruxism (Kononen *et al.* 2006), rather than forces produced by chewing, which are relatively weak due to the soft and refined modern diet. All the above result in differences in wear patterns within the dental arcade, as mastication mainly involves the posterior teeth, whereas bruxism produces more pronounced effects on the anterior teeth (Khan *et al.* 1998).

7.1.1.3 Periodontal disease

As was the case with caries, antemortem tooth loss and wear, the hypothesis regarding periodontal disease was verified. The analysis of data exposed a higher frequency and severity for the modern population of Athens. The difference, however, were not as significant as one might expect, considering the completely different conditions in which the Hellenistic Greeks once lived. More specifically, the results suggest that the consumption of fermentable carbohydrates by the modern population did not have a major effect on periodontal status. The difference between the populations was small considering that modern people consume large amounts of refined sugar and starches. Furthermore, the frequency of surfaces affected by periodontitis in the ancient assemblage was relatively high, in comparison to the 20th century assemblage, whereas for caries, it was quite low. If fermentable carbohydrate consumption had been a major contributing factor in the development of periodontal disease, then periodontitis would have followed the same pattern observed for caries.

Moreover, the absence of significant horizontal alveolar bone loss between an ancient population, who practiced substandard oral hygiene, and a modern, who had access to professional care, treatment and advice, casts serious doubt on the concept of a primary role of bacteria in the aetiology of horizontal crestal bone resorption. It is, thus, suggested that immune response plays a decisive role in the clinical outcome of our encounters with microorganisms (Kilian *et al.* 2006). Systemic (environmental) factors that diminish gingival nutrition, optimal tissue replacement and repair, and basic host defense mechanisms are the determinants of the spread of gingivitis to the deeper tissues. The relatively small differences between the two populations can be attributed to the indirect effect of factors, such as psychosocial disruption, tobacco use, obesity, diabetes, and unhealthy diet, in the modern population, which are known to impair host defenses and, in association with the ageing process, promote periodontal disease (Offenbacher *et al.* 2008).

In conclusion, diet, in terms of fermentable carbohydrate, appears not to have directly influenced the periodontal status of the contemporary sample, or at least, not substantially. However, modern nutrition, in combination with other parameters, had an indirect impact on periodontal health by impairing the immune response of the population.

7.1.1.4 Dental defects of enamel

Comparisons between the Hellenistic and the modern population samples revealed that enamel defects were significantly more common in the former, thus, verifying the hypothesis tested. This variation can be attributed to several factors, namely, breastfeeding practices, weaning, protein consumption, maternal nutritional status, and access to medical care. Breastfeeding and weaning practices in modern times greatly differ from those followed twenty-five hundred years ago. In the 20th century, most Greek women breastfed their children according to the advices of health professionals, who praised breastfeeding and weaning (Pechlivani *et al.* 2008), whereas, in ancient Greece, the lack of medical knowledge on such matters as infant feeding practices most likely had a very negative impact on the health of infants (Garnsey 1999). Prolonged lactation and a weaning diet based on cereals, inadequate to the increasing protein requirements of children, in Hellenistic Greece, in contrast to a much higher protein consumption in the 20th century population, would have contributed to a greater immune susceptibility to disease in the former (Blakey & Armelagos 1985).

Moreover, maternal nutritional status, which greatly influences the health of the foetus, during pregnancy, and the infant, during lactation, should also have contributed to the variation between populations. This supposition is based on evidence that mothers of modern, as opposed to ancient, populations are perhaps less likely to suffer from vitamin D and calcium deficiency, owing to a better nutrition (milk, dairy products, eggs, fish, meat), and vitamin D and calcium supplementation during pregnancy (Cockburn *et al.* 1980; Wilkins & Hill 2006). Additionally, medical advances are undoubtedly a contributing factor. In modern populations, sick, low birthweight, and premature infants are cared for in bassinets designed to limit their exposure to germs, and are given medications that protect them from exposure to disease and prevent malnutrition (Antonucci *et al.* 2009). In pre-industrial populations, although a lower percentage of lowbirth, premature, and sick infants would have survived to be exposed to disease and develop enamel defects, those that did survive would have developed a weaker immune response to illness and possibly higher defect frequencies.

7.1.2 Association between oral conditions and sex and social status

The second set of related hypotheses concerned sex differences in dental health status and wear. The assumptions, for both the Hellenistic population from Demetrias and the 20th century population from Athens, were that females would be more severely affected by carious lesions and antemortem tooth loss, and that they would also exhibit greater physiological disruption, whereas male individuals would show worse periodontal health status and heavier wear. The third set of hypotheses comprised assumptions about differences in the oral status between socioeconomic status groups. For the Hellenistic population, it was expected that there would not be a simple correspondence between presence/absence of grave goods and socioeconomic status and, consequently, no correspondence between socioeconomic status, defined by grave goods, and dental health status. The rationale behind this assumption was that the presence or absence of grave offerings could have been a matter of individual choice rather than an expression of differential status and wealth (E. Nikolaou, *pers. comm.*, 16th September 2009). However, there is the possibility that this assumption is false and that funerary treatment in Hellenistic Demetrias did reflect socioeconomic status in life. In such a case, the assumption was that dental caries, antemortem tooth loss, wear, periodontal disease, and enamel defects rates would be higher in the low socioeconomic status individuals. The same assumption was made for the 20th century assemblage from Athens, although differences in oral pathology prevalence were not expected to be very pronounced, owing to the poor reliability of occupation as a status indicator.

The results indicate that people buried in the North Cemetery of Demetrias were distinguishable in terms of oral pathology and wear, as both sex/gender and socioeconomic status variation was widely evident. Furthermore, they verify the general assumption that oral pathology and wear would differ between the sexes but disprove the hypothesis that no differences would be detected between social status groups. As regards variation between the sexes, some of the more specific hypotheses were verified, whereas others were proved false. The association between social standing and oral pathology and wear was more subtle in the case of the 20th century burial population from Athens, although hypotheses were to a certain extend verified.

7.1.2.1 Dental caries and antemortem tooth loss

With reference to caries and antemortem tooth loss in the low status sample, female individuals suffered both more frequently and more severely than males, whereas for the high status sample, the reverse appears to be the case, with males displaying both higher caries rates and more severe lesions than females. The former outcome was the expected and is attributable to factors determined by the biological tendency of females to suffer from caries more severely than males (Lukacs 2008). However, there is also the possibility that higher protein consumption by men may have also been a contributing factor, as there is literary evidence to support this variation (Garnsey 1999; Wilkins & Hill 2006). The results, therefore, indicate two possible conclusions for the members of the lower classes: either that the diet did not differ between the sexes, or that, although it differed, due to the biological tendency of females to be more severely inflicted by caries, this cannot be inferred from the outcome of this study. Thus, whether or not the social parameters affecting differential access to food resources contribute to this variation between the sexes cannot be answered in this case.

The latter outcome regarding sex differences in caries rates and severity and antemortem tooth loss prevalence in the high status sample disproved the hypothesis, as it points to a significant dietary variation. The conclusion was that socially induced diet-related factors were responsible for this distribution within the population. This was supported by a combination of evidence based on written sources and on data provided by the present study. Literary evidence suggest, first, that males belonged to the advantaged social groups (Fantham 1975), and second, that the status and power of an individual in the household and in society was crucial to food allocation and greatly influenced the foods eaten, their quality, and styles in which they were consumed (Garnsey 1999). Moreover, according to the findings of this research, caries and antemortem tooth loss more frequently and severely affect not only males but, also, all the other socially "privileged" groups, namely high status individuals (females and males together) and males belonging to the high status group, in particular. This is further supported by ancient literary evidence suggesting that the well-off family had an advantage because it had access to a wider range of foodstuffs and more costly regional and imported products (Garnsey 1999).

The consumption of food and drink products that are mentioned by literary sources as being "luxury" items, i.e. meat, fish, olive oil, spices and wine, does not explain the severer affliction of the socially advantaged groups by caries, since none of these "luxury" items are cariogenic. Therefore, it is suggested that other cariogenic items were the distinctive dietary sources for the wealthy that might have contributed to this pattern. These include imported products such as rice and sugarcane, as well as costly local products, namely drinks made from honey or fruits, honey-cakes, wine or water mixed with honey, plums boiled in honeyed wine, as well as preserved fruits, and grape-syrup (Dalby 1996; Gilfillan 1965; Grant 2001).

It was also concluded that another contributing factor to the pattern observed should be sought in the access to and consumption of different starchy foods by the affluent. Black, barley bread was the poor people's bread consumed by the majority of Greeks, whereas white, wheat bread was the bread of the wealthy (Wilkins & Hill 2001). The significance of this variation lies in the difference in the cariogenic potential of the various types of starches, resulting from different methods of processing. Bread baked with intact kernels, i.e. barley bread, gives a low GI and small pH falls, in contrast to kernel-based bread, i.e. wheat bread, which results in much lower pH values and is, therefore, more cariogenic (Lingstrom *et al.* 2000). A greater blood glycose response and larger pH drops also occur after the consumption of cooked compared to raw food (Collings *et al.* 1981). This piece of evidence is of great importance to the present research, as the affluent consumed cooked food much more often than the poorer (Gilfillan 1965), since food preparation was time-consuming and required space, and wood fuel was expensive (Wilkins & Hill 2006; Hughes & Thirgood 1982).

To summarise all the above, according to literary sources, men of low status ate more meat and drank more wine, but, as indicated by the results of this study, did not have a more cariogenic diet than women. Males of the high status assemblage were the most severely affected of all subgroups and, consequently, the most favoured. This is in accordance with written sources, which suggest that women were discriminated against not only in the lower, but also in the upper classes. However, it appears that where women participated in work outside the household, the gap between the sexes in the division of food would probably have been narrower than where women were confined to the home (Garnsey 1999). This might explain both the lack of significant sex-related differences in cariogenicity of the diet of the low status group and the dietary variation in the high status group. Moreover, although women of high status were favoured over their low status counterparts, both female and male, they were nevertheless less privileged than men of high status.

The findings produced for sex differences in the modern population of Athens were similar, though not as pronounced, to the results for Demetrias (for the high status group only), but they do not support the hypothesis that female individuals would be more severely affected by caries than males. Oral hygiene was possibly one of the significant contributing factors to the severer caries affliction of males. Studies have reported a more pronounced preventive oral health behaviour for females, in terms of more frequent visits to the dentist and more attention to personal oral hygiene practices (Coda Bertea *et al.* 2007). Nevertheless, research has yielded the paradox that, although women take more care of their teeth, they do not have a better oral health than men (Al-Omari & Hamasha 2005). Considering that, in spite of this, males were more severely affected in this study, it can be suggested that some dietary factor contributed to this sex variation. However, there is no indication that the male diet was more cariogenic than the female diet in 20th century Greece (Arvaniti *et al.* 2006; Georgakis 2001; Mantis 2001; Trichopoulou & Lagiou 2001). In the absence of other evidence and bearing in mind that the difference observed between the sexes was not a substantial one, it is suggested that the explanation should be sought in differential oral hygiene behaviours, which might well have resulted in a slightly higher rates of caries for male individuals.

The results for socioeconomic status differences in the modern population of Athens differ from those observed in Demetrias and support the hypothesis that low status individuals would be more severely affected by caries than their high status counterparts. This variation is in accordance with other studies on industrial populations and written records of food distribution among the social classes in 20th century Greece. Previous studies have demonstrated a strong association between caries severity and socioeconomic status (Harris *et al.* 2004), due to limited access to professional health care and treatment, as well as negative attitudes towards personal oral hygiene behaviours (Polk *et al.* 2010). As regards dietary variation in relation to socioeconomic environment, carbohydrate and protein consumption very much varied according to social standing in 20th century Greece. More specifically, the dietary importance of cereals and vegetables, that is their contribution to total energy availability, diminished with increasing affluence, whereas the opposite was the case for meat and eggs (Matalas 2001).

7.1.2.2 Occlusal wear

Data analysis of wear patterns in Demetrias suggested an association between wear and sex as well as between wear and social status. Moreover, it verified the hypothesis that males would exhibit more occlusal wear due to men's heavier reliance on meat, whereas the hypothesis that there would not be an association between wear and social ranking was disproved. In brief, the results indicated that males and low status individuals displayed heavier wear than females and high status individuals, respectively. This was the case for males of both low and high status as well as for low status individuals of both sexes. All these patterns point towards a significant dietary variation determined by social position in the family and within society. Furthermore, they are consistent with the findings produced for dental caries and antemortem tooth loss, which suggest a different diet for the socially privileged groups. In contrast to caries, however, results for occlusal wear indicate subsistence differences for males, a socially privileged group, and low status individuals, a socially disadvantaged group. The two outcomes for caries and wear do not contradict each other as, in the case of Demetrias, they appear to be influenced by factors that are independent of one another.

The answer to which foods might have contributed to heavier occlusal wear in males and individuals representing the disadvantaged people of Hellenistic Demetrias, was sought in literary sources, which suggest that women consumed less meat, fish and aquatic food in general, as well as wine and wine in combination with honey (Garnsey 1999; Prowse *et al.* 2005). Meat is a tough substance that requires a significant amount of work to cut or fracture it (Lucas & Peters 2000), and it thus has an indirect effect, that is to say tooth-on-tooth abrasion due to the extreme mechanical demands required for its mastication (El-Zaatari 2008; 2010). Moreover, the reliance on fish, particularly if dried, and other marine foods, such as shellfish, has been connected to high rates of heavy wear, in association with a high content of grit (Littleton & Frohlich 1993). Finally, wine may have also contributed to heavier wear in males, as it has an erosion potential, which makes dentine vulnerable to acidic attacks (Albashaireh & Al-Shorman 2010).

Access to meat, aquatic foods and possibly wine was more frequent for the well-off members of the ancient Greek society too (Garnsey 1999; Wilkins & Hill 2006). The results, however, contradict the literary evidence, thus indicating that there were other dietary factors influencing the distribution of heavy wear rates between status groups in Demetrias. It has already been extensively discussed that the affluent families consumed more refined and processed foods than the poorer families. More specifically, the well-off consumed soft, white, wheat-based bread, whereas the poor ate hard, black, unleaved barley or rye bread. The great masticatory force required for the ingestion of hard food items, such as those consumed by the members of the lower classes, would have heavier wear as a result. Additionally, a diet of harder objects, such as hard seeds and husked grains, produce heavily pitted tooth surfaces (El-Zaatari 2010), which predispose to gross dental tissue loss (Schmidt 2010). The affluent also consumed cooked food much more often than their poorer counterparts, which would have also contributed to a generally softer diet that requires less powerful mastication and also little chewing time (Deter 2009). The wealthy also most likely consumed more fresh than dried food, succulent versus tough meat, as well as farmed crops, which require less processing (Scheidel 1995).

Results for wear in the dental material from Athens were similar to those observed in the ancient population and verified the hypothesis that the teeth of males would be more heavily worn than those of females. This is most probably associated with the higher consumption of meat by males. This is strongly supported by the statistical data that exists for 20th century Greece, which suggests that the main difference in food distribution between the sexes in 20th century Greece, was observed in the consumption of meat (Arvaniti *et al.* 2006; Βαρδάκη 2001). As far as the difference between the two status groups is concerned, the low status sample displayed heavier wear than the high status sample, which is a pattern that verifies the hypothesis and has also been observed in Demetrias. This difference is attributed to the consumption of more refined and softer foods by the well-off and this is also supported by the caries distribution pattern between the social groups.

7.1.2.3 Periodontal disease

Results for periodontal disease in Demetrias showed that low status females were more severely affected by the condition than their male counterparts, whereas high status females were less severely afflicted than males of the same status. The most severely affected were the members of the socially disadvantaged segments, i.e. the low status group as whole (females and males together) and females of the low status group. Interestingly, the exact opposite was the case for dental caries, which affected the groups that represented the socially advantaged segments of the society. This contrast is an indication that carbohydrate consumption has not been the cause of the variations detected between subgroups in Demetrias. The same conclusion is also supported by the differences detected between the ancient and the modern population discussed earlier.

The severer affliction of males in the high status sample was an expected outcome and it is attributable to the general tendency of males to be at greater risk due to biological factors, as oestrogen protects females against destructive periodontal bone loss (Genco 2000, 15). The severer affliction of females in the low status group in comparison with males of the same SES, and of low status individuals (females and males together) in comparison with high status individuals, however, appears to be the result of underlying social parameters. Ancient written sources suggest that systemic diseases and nutritional deficiencies, as well as immunodeficiency, which predispose to periodontal disease, more frequently occurred, or were more likely to have occured, in the socially disadvantaged segments of the society, that is to say, individuals coming from the lower socioeconomic classes and women. For instance, acquired iron-deficiency anaemia and calcium deficiency are generally more common in females, as a result of stresses and iron losses due to pregnancy, lactation and menstruation (Larsen 1997). Another example is meat, which is rich in iron, and fruits, which are rich in vitamic C; they were not staples and were therefore rarely consumed by the socially "inferior". All the above would have impaired general health and could thus have an impact on periodontal health. Viewed differently, the latter could potentially provide evidence for the former, that is to say that periodontal health may reflect, to some extent, the general health status of a population.

In the modern population the results for the distribution of periodontal disease differed from those seen in the ancient population but also had some similarities. They were, nevertheless, less complicated. Briefly, males were more severely affected than females, whereas high status individuals experienced periodontitis more frequently but less severely than their low status counterparts. The difference between the sexes, though not marked, can be attributed to the biological tendency of males to be at higher risk than females, most likely due to hormonal effects (Albandar 2008; Genco 2000). The less frequent (overall in the sample) but more severe and extensive affliction of low SES individuals points at a weaker immune response.

7.1.2.4 Dental defects of enamel

The results for dental enamel defects also suggested a strong association between health status of burial populations and socioeconomic status in life. First of all, it should be noted that the association found between the prevalence of enamel defects and the risk of dying later on in adulthood in this study, strongly suggests that the individuals displaying physiological disruption indicators represent those that experienced greater physiological disruption into adulthood. This finding suggests that, although the individuals with the highest rates of defects had an immune response strong enough to allow them to survive into adulthood, they died at a younger age than those with lower defect rates. Besides, enamel hypoplasia is associated with diseases that may not be life-threatening (Brook 2009; Griffin & Donlon 2009); they may, however, have an impact on the morbidity and mortality of the individual later on in his/her life (Smith *et al.* 1998), which appears to be the case in the Demetrias population.

Comparisons between the sexes within each social group, separately, revealed that, in the high status group, males had a slightly higher proportion of hypoplastic teeth than females, whereas, in the low status group, female teeth were significantly more often affected than male teeth. Literary evidence for ancient Greece suggests that boys were favoured over girls, although there is no direct information regarding, for instance, differential breast-feeding practices. However, there is indirect evidence, such as the practice of female exposure, which certainly denotes a preference towards them. In a society where preference is given to the sons, there might have been a favouring of the male infant/child in terms of physical care and nourishment (Patterson 1985). Especially in cases of food shortages, which were quite common in Hellenistic Thessaly (Garnsey 1988), this preference would have had an impact on the childcare and access to basic food resources of female children (Faerman & Smith 2008). This appears to be the case for the low socioeconomic infants/children of Demetrias only, given that in the high socioeconomic group, males had more hypoplastic teeth than females. This should not attributed to different cultural beliefs and social equality in the upper classes, but rather to the fact that there was no practical need for differential treatment of female infants/children, as subsistence crises did not have a great impact on the well-off families (Gallant 1989).

Comparisons between social status groups showed very marked differences, as low status teeth were almost three times more frequently affected than high status teeth and low status individuals were almost twice as much afflicted as their high status counterparts. This was also the case when low and high status group comparisons were made both for each sex subgroup separately and in all three age classes. These differences between SES groups may well be the result of food shortages, which had a greater impact on the lower socioeconomic classes. This, however, might not have been the only causative factor. Women of the upper classes would have been healthier and better nourished than their poorer counterparts, and that would consequently have positively influenced their children's health (Raiten *et al.* 2007). Additionally, whenever food was scarce, maternal feeding would have been the only nutritional source for infants in the poorer households; if maternal feeding, as the only nutritional source, is prolonged over six months, however, this would result in a protein and calorie deficiency (Lovell & Whyte 1999). Moreover, well-off families had an advantage at the weaning stage because they had access to a wider range of foodstuffs, especially some that were good protein sources (Garnsey 1999), would have afforded less crowding space and less unsanitary conditions and would have also been better protected by the effects of weather in the winter (King *et al.* 2005).

In the modern population, more male than female individuals showed signs of enamel defects, in both status groups. This result proves the hypothesis false, as it was expected that females would show more physiological disruption, due to preference for sons in 20th century Greece (Pashos 2000). The finding that males exhibited higher enamel hypoplasia rates, although they were favoured during childhood, may well indicate that they were more vulnerable to physiological disruption (Guatelli-Steinberg & Lukacs 1999). Differences between status groups were considered for males only, because the female sample, especially that of high status, was very small. It was, thus, found that low status individuals were more severely affected. This trend, which was also observed in the archaeological population, can be associated with factors that favoured high status infants and children. These include better nutrition, superior breastfeeding and weaning practices, less crowding and unsanitary conditions, protection by the effects of severe weather, lesser exposure to infections, stronger immune response, access to medical care and medication, and better maternal health and nutritional status.

7.2 Concluding Remarks

The present research has significantly contributed to exploring the issues, among others, of the association between biological and social status, the importance of biologically- and socially-determined factors influencing sex/gender differences in oral and overall health, and the variation between ancient and modern populations in terms of oral pathology and general well-being. Furthermore, it has been shown how much bioarchaeological studies can benefit from employing a detailed methodology by producing results that are less biased in terms of differential preservation, severity of the conditions, sex and age structure of the sample, tooth susceptibility hierarchy, and so on. Moreover, this study is the first large-scale systematic study of a single-period cemetery site in the area of Thessaly. It has shed light on certain, so far unknown, life aspects of the inhabitants of one of the most economically and politically powerful towns of Hellenistic Greece, which is, at the same time, one of the most important archaeological sites dating to this period of Greek history.

The data from Demetrias and its interpretation suggest several important conclusions and answer crucial and widely debated archaeological questions. One of the first things that was ascertained is that variation between the sexes and the social status groups was undoubtedly apparent in all the dental indicators studied for the purposes of this thesis. Although there were exceptions, such as in the case of higher periodontitis rates in males of the high status sample, in most cases, social factors appear to have played a major part in the variations observed among subgroups. This finding strongly suggests that (a) the sensitivity of the biological indicators employed appears to be adequate to reveal fine differences in the standard of living among socially determined groups, (b) social position, in the family and within the society in general, strongly influenced the diet, nutrition and overall health of the Demetrias population, (c) grave goods appear to reflect important dimensions of social variability.

With regard to the first conclusion, the analysis of all the oral conditions considered in this thesis produced very conclusive differences among subgroups and, consequently, suggests that oral pathology and wear are very strong indicators of social conditions and status. This association between dental indicators and social status in the Demetrias population is the result of a combination of factors, two of which are the aforementioned conclusions *b* and *c*. First is the factor of the nature of the population sample; more specifically, its preservation and the fact that all individuals included in the analysis are assigned to a sex, age and socioeconomic status category. Second is the systematic nature of the study, which identifies, evaluates and synthesises all available evidence relevant to the purpose of the research, and employs a detailed methodology in order to reduce bias. Another factor, which is also a premise for establishing a relationship between biological and social status, is that the society in question is stratified into hierarchical social groups, and that this society consistently discriminates against some of its segments, in some way. The representation of a reasonably wide social spectrum in the assemblage under study is also a factor and a precondition. Furthermore, the health indicators employed relate to certain dietary habits, nutrition and overall health; although this relationship appears to be self-evident, there are several complications inherent to it (Robb *et al.* 2001). Finally, there are two more factors and preconditions (conclusions *b* and *c*); first, that social position influences aspects of life strongly associated with the causes of dental conditions, and, secondly, that mortuary treatment, to a certain extent, reflects socioeconomic status in life.

As far as the second conclusion, i.e. the influence of social position in health, is concerned, results suggest that of all indicators, the ones that produced the most conclusive results and most strongly reflected socioconomic status in Demetrias were caries and enamel defects. This finding does not necessarily denote that tooth decay and enamel hypoplasia are always better guides to social conditions; rather, which features emerge as socially significant very much depends on the locally specific nature of the biological stresses and their social allocation (Robb *et al.* 2001, 220). Data on both wear and periodontal disease also produced important conclusive differences between the sexes and status groups, and very much helped with testing hypotheses and creating a more complete picture of the biological status and of certain life aspects in Demetrias. Equally important was their contribution to assessing the reliability of the other indicators. Interestingly, it has emerged that all indicators complement one another and point towards the same direction; they are also supported by or are in accordance with literary evidence.

In reference to the conclusion that grave goods reflect important dimensions of social variability, one may suggest that the lack of a more detailed chronological framework and other archaeological evidence allows for the possibility that the group of individuals buried without grave goods may represent people living in economically suppressed times, rather than a lower socioeconomic class. Theoretically, this is always a possibility in similar cases and in the case of Demetrias, the burials without grave goods could belong to the Late Hellenistic, which was a period of decline for the town (Batziou-Efstathiou 2001). However, as indicated by the archaeologist studying the cemetery, there are burials with grave goods that belong to the Late Hellenistic period and, furthermore, some of them are very rich, containing a variety of artefacts made of precious metals (E. Nikolaou, *pers. comm.*, 16th November 2010). The bioarchaeological evidence provided by the present thesis also diminishes the likelihood of the group in question not representing a lower social class. These include the findings that a correspondence between biological and social status was also found for the sexes, and that there were also differences between the females and males in combination with social class, e.g. between high status females and high status males, or between low status males and high status males, and so on. Additionally, the results and their interpretation are supported by evidence provided by written sources. It is, therefore, highly unlikely that the individuals not accompanied by grave artefacts represent people living in economically suppressed times, rather than a low status group.

In conclusion, according to the evidence provided by the present research, Hellenistic Demetrias appears to have been a strongly hierarchical society, in which men, particularly those that were members of the upper classes, were more favoured than women. This favouritism is evident both in the adult life and during infancy/childhood, although it should again be noted that the inference concerning infants is made based on evidence coming from adult individuals. Interestingly, whereas the position of women in society as a whole was "inferior" to that of men, where women participated in work outside the household, the gap between the sexes in the division of food was probably narrower, at least in terms of food allocation. However, as far as nutrition, presumably iron, vitamin C and calcium intake, and immune response is concerned, this was not the case, as the data of this study, in association with literary evidence, indicates that females of the lower social classes were less "healthy" than their male counterparts. Male infants/children were also given priority over female infants/children in terms of care and nutrition. However, this behaviour most likely occured only when there was a practical need for differential treatment, such as in cases of subsistence crises, in the poorer classes, as food shortages did not have a major impact in the well-off families.

As was the case for the sexes, low and high status groups did not suffer the same health risks, as members of the upper classes clearly enjoyed a much more privileged position than those of lower social position. The purchasing power of the well-off families appears to have offered them a higher quality diet, especially in time of subsistence crisis, better nutrition and stronger immune response. High status infants/children possibly had the benefit of better nutrition during breastfeeding and weaning, better maternal overall health and access to some medical care, lived in less unsanitary conditions and thus were less exposed to infection. Additionally, it is worthy of note that high socioeconomic status was strongly associated with poor oral health, i.e. high prevalence of tooth decay, because it happens that several of the food and drink items regarded as luxury and being the most expensive in the specific society were cariogenic. Therefore, poor oral health should not always be interpreted as an indication of low social status. This finding stresses the importance of the need to contextualise the analysis of human remains culturally.

Evaluation of the variation observed among subgroups in the Demetrias population led to the conclusion that the most socially privileged of all segments of society, were male individuals of high status, whereas the least privileged were females of low status. Futhermore, high status females appear to have been in a more advantaged position in relation to low status females, but also in relation to low status males. Also, it seems that it is not by chance that males (regardless of status), high status males, and the high status group (regardless of sex) reached an older age than females, high status females, and the low status group, respectively. This, in combination with the evidence on oral pathology and wear, further supports the conclusion that the groups representing the advantaged segments of the society of Demetrias were indeed privileged in terms of general well-being that apparently resulted in an increased lifespan.

Comparisons between the two populations revealed that environmental, cultural and socioeconomic circumstances did not have the same effect on all the conditions studied for the purposes of this thesis. The prevalence and severity of dental caries, as well as antemortem tooth loss and wear, were vastly influenced by life patterns in industrial societies, whereas the difference in the frequency of enamel defects, though it was considerable, was not as marked as that observed for caries and antemortem tooth loss. Interestingly, the effect was not significant for periodontal disease. Diet, more specifically processing and preparation methods rather than food and drink items themeselves, was responsible for the most significant variation, i.e. that seen in caries and wear pattern. Oral hygiene practices and professional treatment, on the other hand, did not have a major positive effect on oral health status, especially periodontal disease. Furthermore, consumption of fermentable carbohydrates appears not to have had an impact on the periodontal status of the modern population. Twentieth-century medical advances, however, positively influenced the nutritional status and health of infants/children, protecting them from undernourishment and disease.

In terms of oral pathology and wear distribution between the sexes and the socioconomic status groups, there were both similarities and differences between the two populations. Caries variation between the sexes was evidently more pronounced in Demetrias with the patterns observed clearly reflecting differential status between females and males. In contrast, the slight difference observed in Athens, is not indicative of some pronounced dietary or social status differentiation. The results for socioeconomic status groups completely differ between the two assemblages. In Demetrias, it appears that high caries prevalence is suggestive of high social status, whereas, in Athens, the exact opposite is the case. These seemingly contradictory outcomes stress the need for contextual reading of findings.

Data analysis of wear distribution within the assemblages points towards dietary variation influenced by sex/gender and social class. Thus, in both ancient and modern Greece, the more regular consumption of a tougher diet, namely meat, by males seems to contain a strong underlying cultural symbolism that has lasted for thousands of years. On the other hand, the association between social standing and a more refined diet consumed by the upper classes, is possibly more a matter of purchasing power, particularly in the Hellenistic society, although this does not rule out the possibility of a symbolic meaning. Periodontal disease distribution between socioeconomic status samples was similar between the archaeological and the contemporary assemblages, and point at a weaker immune response in the members of the lower classes. As regards differences between the sexes, the findings for Demetrias possibly reflect the inferior status of women, whereas for Athens, there is no such indication.

Sex variation in enamel defects differed considerably between the ancient and the contemporary population. In the ancient population, the markedly higher prevalence of hypoplasia in the females of the lower status group seem to strongly suggest the favouring of the male infant/child, in terms of physical care and nourishment. In contrast, in the contemporary assemblage, the evidence for differential treatment between female and male infants (Pashos 2000) is not supported. The trends observed for enamel defects between socioeconomic status groups, however, were very similar between Demetrias and Athens, although the difference was more pronounced in the former. They are thus thought to reflect the unfavourable conditions experienced by the lower socioeconomic classes quite accurately.

In conclusion, the present thesis highlights the high potential of bioarchaeological studies to provide invaluable information on the life of past people. Moreover, it stresses the value of mortuary evidence and their potential association to social status in life, as well as the necessity to report and analyse data by sex and age. Finally, it emphasises that skeletal analysis should be carefully contextualised socially, archaeologically and historically, when relevant evidence is available, as the interpretation of the findings very much depends on the specific nature of environmental and cultural circumstances.

7.3 Limitations and Future Directions

Limitations and difficulties are inherent to all bioarchaeological studies, although their nature varies from case to case. Preservation in the contemporary collection and the sample size of both assemblages do not constitute a real drawback in this particular research, as the Athens remains are excellently preserved and the samples' size, both in terms of number of sex and aged individuals and number of teeth/interseptal areas observable, was relatively large. However, problems with regard to the preservation of the Demetrias remains, the representativeness of the samples, the estimation of sex and age, and the non-specificity of the lesions, limited the reliability and the information that could be obtained. In addition to these complications, the large number of fillings in the modern population obscured the actual pattern of caries and occlusal wear. Furthermore, the size of some of the subsamples, namely that of high status females or older males, was quite small, as most women were registered as "housewives" and older males as "retired" (Eliopoulos 2006). It was also not easy to interpret the findings mainly due to the multifactorial aetiology of the conditions. The complicated nature of the biological and social factors influencing pathology and wear prevalence and pattern rendered the understanding of the interaction among these parameters difficult. Nevertheless, the assessment of these parameters yielded a wealth of information on the pastistic inhabitants of Hellenisitic Demetrias and 20th century Athens.

The present research does not comprise a complete and exhaustive work on analyses of the burial population of Demetrias. Further macroscopic, microscopic and chemical examination of the North Cemetery human remains will contribute to the reconstruction of a more complete picture of the society they once represented. Moreover, the publication of the results for skeletal pathology and trauma already recorded and analysed but not included in this thesis due to space limitations, will help to explore other aspects of the biological quality of life of the people of Demetrias.

In the future, when more detailed mortuary evidence for the Demetrias population becomes available, the effect of social conditions on the distribution of disease between the sexes and among the socioeconomic status groups will be investigated further. A future direction is also to compare the data provided by this study with that from other Hellenistic population studies, which are very few at present. It should also be noted that the data obtained by this research project provides the first direct or indirect evidence on the population's health status and on sex/gender and social status variation in this area of Greece in the Hellenistic period; again this makes it difficult to put it into a wider context. However, it provides a basis for future studies on the bioarchaeology of the region of which very little is known in terms of population biology, everyday life and social conditions.

Appendix I

ILLUSTRATIONS

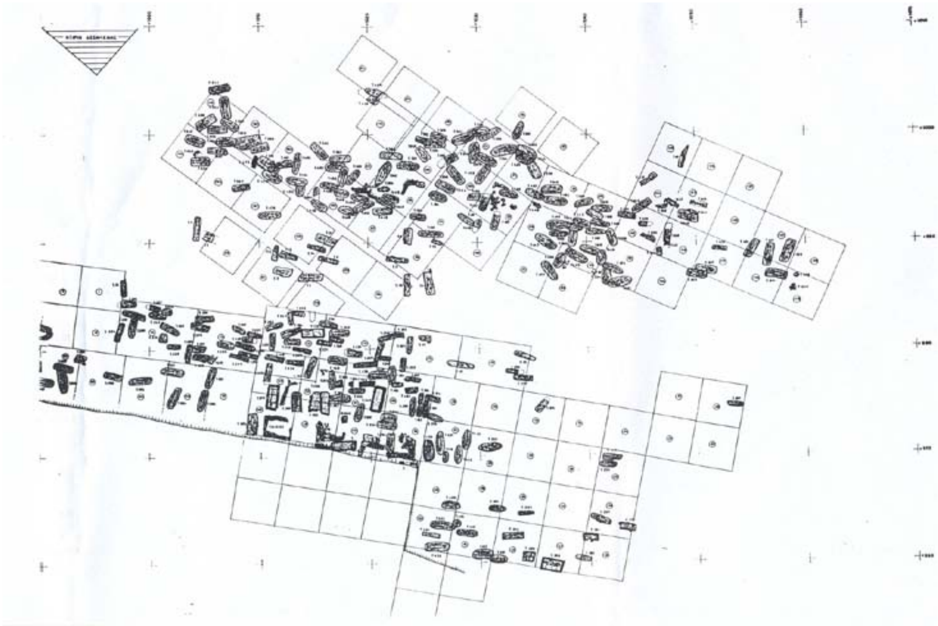

Illustration I.1: Excavation plan of the North Cemetery of Demetrias

(Drawing provided by E. Nikolaou)

Illustration I.2: Multiple burial (no. 386) accompanied by grave goods

(Photo: E. Nikolaou)

Illustration I.3: Burial (no. 714) without grave goods (Photo: E. Nikolaou).

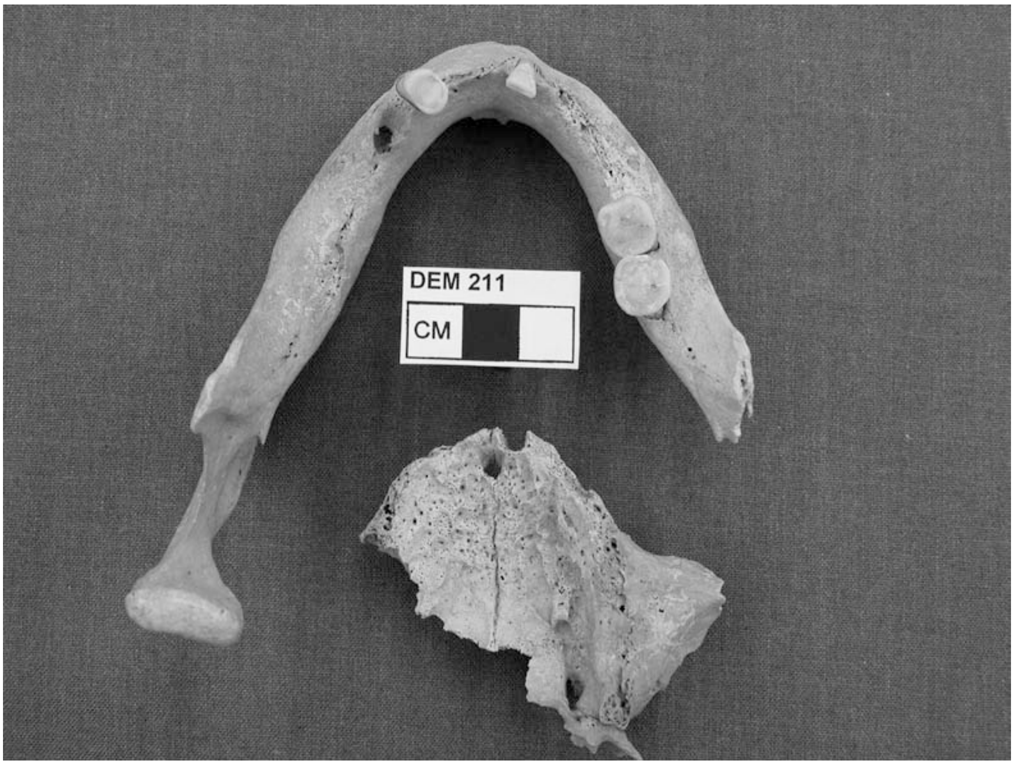

Illustration I.4: Antemortem tooth loss and occlusal wear in the maxilla and mandible of a middle adult male individual (no. 211) from Demetrias (Photo: V.Vanna).

Illustration I.5: Antemortem tooth loss in the maxilla of an older male individual (no. 885) from Demetrias (Photo: V.Vanna).

Illustration I.6: Caries and occlusal wear in the mandible of an older male individual (no. 885) from Demetrias (Photo: V.Vanna).

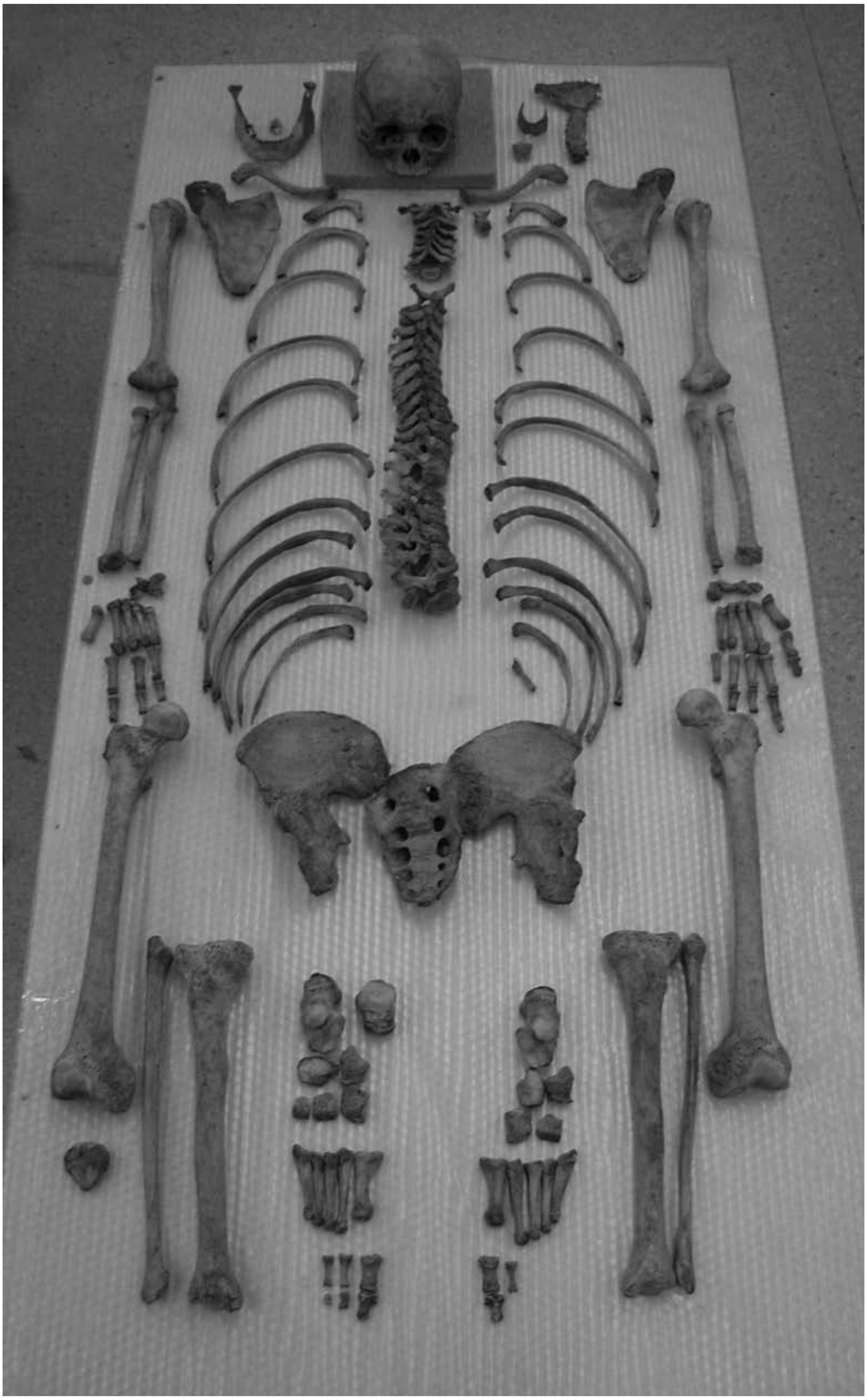

Illustration I.7: Skeleton from the Athens Collection (Photo: C. Eliopoulos).

Illustration I.7: Dental defects of enamel in the mandible of a young male individual (no. 221) from Athens Collection (Photo: V. Vanna).

Illustration I.8: Caries, antemortem tooth loss and periodontal disease in the mandible of a young male individual (no. 221) from Athens Collection (Photo: V. Vanna).

Appendix II

TABLES OF FREQUENCIES FOR ORAL PATHOLOGY AND WEAR

		Not affected by	Pulp lesions	Dentine lesions	Enamel lesions	
1	**N**	336	4	12	3	355
		94.60%	1.10%	3.40%	0.80%	100.00%
2	**N1**	374	7	14	5	400
		93.50%	1.80%	3.50%	1.30%	100.00%
3	**N**	520	10	14	8	552
		94.20%	1.80%	2.50%	1.40%	100.00%
4	**N**	505	19	20	7	551
		91.70%	3.40%	3.60%	1.30%	100.00%
5	**N**	479	17	16	3	515
		93.00%	3.30%	3.10%	0.60%	100.00%
6	**N**	450	31	34	7	522
		86.20%	5.90%	6.50%	1.30%	100.00%
7	**N**	483	24	28	7	542
		89.10%	4.40%	5.20%	1.30%	100.00%
8	**N**	321	16	19	3	359
		89.40%	4.50%	5.30%	0.80%	100.00%
Total	**N**	**3468**	**128**	**157**	**43**	**3796**
		91.40%	**3.40%**	**4.10%**	**1.10%**	**100.00%**

Table II.1: Number (N) and percentages (%) of teeth present and observable, and with pulp, dentine, and enamel lesions in **Demetrias**.

		Not affected	Pulp lesions	Dentine lesions	Fillings	Enamel lesions	
1	**N**	76	3	11	2	2	94
		80.90%	3.20%	11.70%	2.10%	2.10%	100.00%
2	**N**	99	10	7	3	4	123
		80.50%	8.10%	5.70%	2.40%	3.30%	100.00%
3	**N**	138	17	9	10	7	181
		76.20%	9.40%	5.00%	5.50%	3.90%	100.00%
4	**N**	89	23	16	29	6	163
		54.60%	14.10%	9.80%	17.80%	3.70%	100.00%
5	**N**	74	12	17	30	5	138
		53.60%	8.70%	12.30%	21.70%	3.60%	100.00%
6	**N**	68	24	18	84	5	199
		34.20%	12.10%	9.00%	42.20%	2.50%	100.00%
7	**N**	89	24	35	84	5	237
		37.60%	10.10%	14.80%	35.40%	2.10%	100.00%
8	**N**	59	26	23	29	4	141
		41.80%	18.40%	16.30%	20.60%	2.80%	100.00%
Total	**N**	**692**	**139**	**136**	**271**	**38**	**1276**
		54.20%	**10.90%**	**10.70%**	**21.20%**	**3.00%**	**100.00%**

Table II.2: Number (N) and percentages (%) of teeth present and observable, and with pulp, dentine, and enamel lesions in **Athens**.

		Not by caries	Pulp lesions	Dentine lesions	Enamel lesions	Total
1	**N**	140	1	6	1	148
		94.60%	0.70%	4.10%	0.70%	100.00%
2	**N**	165	1	5	2	173
		95.40%	0.60%	2.90%	1.20%	100.00%
3	**N**	211	4	7	5	227
		93.00%	1.80%	3.10%	2.20%	100.00%
4	**N**	205	8	9	5	227
		90.30%	3.50%	4.00%	2.20%	100.00%
5	**N**	190	10	7	2	209
		90.90%	4.80%	3.30%	1.00%	100.00%
6	**N**	197	7	15	1	220
		89.50%	3.20%	6.80%	0.50%	100.00%
7	**N**	199	9	11	5	224
		88.80%	4.00%	4.90%	2.20%	100.00%
8	**N**	125	7	9	2	143
		87.40%	4.90%	6.30%	1.40%	100.00%
Total	**N**	**1432**	**47**	**69**	**23**	**1571**
		91.20%	**3.00%**	**4.40%**	**1.50%**	**100.00%**

Table II.3: Number (N) and percentages (%) of teeth present and observable, and with pulp, dentine, and enamel lesions in **female** individuals from **Demetrias**.

		Not by caries	Pulp lesions	Dentine lesions	Enamel lesions	Total
1	**N**	196	3	6	2	207
		94.70%	1.40%	2.90%	1.00%	100.00%
2	**N**	209	6	9	3	227
		92.10%	2.60%	4.00%	1.30%	100.00%
3	**N**	309	6	7	3	325
		95.10%	1.80%	2.20%	0.90%	100.00%
4	**N**	300	11	11	2	324
		92.60%	3.40%	3.40%	0.60%	100.00%
5	**N**	289	7	9	1	306
		94.40%	2.30%	2.90%	0.30%	100.00%
6	**N**	253	24	19	6	302
		83.80%	7.90%	6.30%	2.00%	100.00%
7	**N**	284	15	17	2	318
		89.30%	4.70%	5.30%	0.60%	100.00%
8	**N**	196	9	10	1	216
		90.70%	4.20%	4.60%	0.50%	100.00%
Total	**N**	**2036**	**81**	**88**	**20**	**2225**
		91.50%	**3.60%**	**4.00%**	**0.90%**	**100.00%**

Table II.4: Number (N) and percentages (%) of teeth present and observable, and with pulp, dentine, and enamel lesions in **male** individuals from **Demetrias**.

		Not affected	Pulp lesions	Dentine lesions	Fillings	Enamel lesions	Total
1	**N**	24	1	8	2	0	35
		68.60%	2.90%	22.90%	5.70%	0.00%	100.00%
2	**N**	42	6	2	1	1	52
		80.80%	11.50%	3.80%	1.90%	1.90%	100.00%
3	**N**	60	6	3	3	3	75
		80.00%	8.00%	4.00%	4.00%	4.00%	100.00%
4	**N**	37	8	2	14	3	64
		57.80%	12.50%	3.10%	21.90%	4.70%	100.00%
5	**N**	36	4	2	19	1	62
		58.10%	6.50%	3.20%	30.60%	1.60%	100.00%
6	**N**	35	7	7	50	1	100
		35.00%	7.00%	7.00%	50.00%	1.00%	100.00%
7	**N**	40	8	12	49	2	111
		36.00%	7.20%	10.80%	44.10%	1.80%	100.00%
8	**N**	29	11	6	13	1	60
		48.30%	18.30%	10.00%	21.70%	1.70%	100.00%
Total	**N**	**303**	**51**	**42**	**151**	**12**	**559**
		54.20%	**9.10%**	**7.50%**	**27.00%**	**2.10%**	**100.00%**

Table II.5: Number (N) and percentages (%) of teeth present and observable, and with pulp, dentine, and enamel lesions in **female** individuals from **Athens**.

		Not affected	Pulp lesions	Dentine lesions	Fillings	Enamel lesions	Total
1	**N**	52	2	3	0	2	59
		88.10%	3.40%	5.10%	0.00%	3.40%	100.00%
2	**N**	57	4	5	2	3	71
		80.30%	5.60%	7.00%	2.80%	4.20%	100.00%
3	**N**	78	11	6	7	4	106
		73.60%	10.40%	5.70%	6.60%	3.80%	100.00%
4	**N**	52	15	14	15	3	99
		52.50%	15.20%	14.10%	15.20%	3.00%	100.00%
5	**N**	38	8	15	11	4	76
		50.00%	10.50%	19.70%	14.50%	5.30%	100.00%
6	**N**	33	17	11	34	4	99
		33.30%	17.20%	11.10%	34.30%	4.00%	100.00%
7	**N**	49	16	23	35	3	126
		38.90%	12.70%	18.30%	27.80%	2.40%	100.00%
8	**N**	30	15	17	16	3	81
		37.00%	18.50%	21.00%	19.80%	3.70%	100.00%
Total	**N**	**389**	**88**	**94**	**120**	**26**	**717**
		54.30%	**12.30%**	**13.10%**	**16.70%**	**3.60%**	**100.00%**

Table II.6: Number (N) and percentages (%) of teeth present and observable, and with pulp, dentine, and enamel lesions in **male** individuals from **Athens**.

		Not affected	Pulp lesions	Dentine lesions	Enamel lesions	Total
1	**N**	170	0	0	0	170
		100.00%	0.00%	0.00%	0.00%	100.00%
2	**N**	203	1	1	0	205
		99.00%	0.50%	0.50%	0.00%	100.00%
3	**N**	280	3	1	1	285
		98.20%	1.10%	0.40%	0.40%	100.00%
4	**N**	273	8	3	2	286
		95.50%	2.80%	1.00%	0.70%	100.00%
5	**N**	265	7	4	2	278
		95.30%	2.50%	1.40%	0.70%	100.00%
6	**N**	266	14	8	0	288
		92.40%	4.90%	2.80%	0.00%	100.00%
7	**N**	292	7	6	0	305
		95.70%	2.30%	2.00%	0.00%	100.00%
8	**N**	178	4	7	0	189
		94.20%	2.10%	3.70%	0.00%	100.00%
Total	**N**	1927	44	30	5	2006
		96.10%	2.20%	1.50%	0.20%	100.00%

Table II.7: Number (N) and percentages (%) of teeth present and observable, and with pulp, dentine, and enamel lesions in **low SES** individuals from **Demetrias**.

		Not affected	Pulp lesions	Dentine lesions	Enamel lesions	Total
1	**N**	166	4	12	3	185
		89.70%	2.20%	6.50%	1.60%	100.00%
2	**N**	171	6	13	5	195
		87.70%	3.10%	6.70%	2.60%	100.00%
3	**N**	240	7	13	7	267
		89.90%	2.60%	4.90%	2.60%	100.00%
4	**N**	232	11	17	5	265
		87.50%	4.20%	6.40%	1.90%	100.00%
5	**N**	214	10	12	1	237
		90.30%	4.20%	5.10%	0.40%	100.00%
6	**N**	184	17	26	7	234
		78.60%	7.30%	11.10%	3.00%	100.00%
7	**N**	191	17	22	7	237
		80.60%	7.20%	9.30%	3.00%	100.00%
8	**N**	143	12	12	3	170
		84.10%	7.10%	7.10%	1.80%	100.00%
Total	**N**	**1541**	**84**	**127**	**38**	**1790**
		86.10%	**4.70%**	**7.10%**	**2.10%**	**100.00%**

Table II.8: Number (N) and percentages (%) of teeth present and observable, and with pulp, dentine, and enamel lesions in **high SES** individuals from **Demetrias**.

		Not affected	Pulp lesions	Dentine lesions	Fillings	Enamel lesions	Total
1	**N**	24	1	2	0	0	27
		88.90%	3.70%	7.40%	0.00%	0.00%	100.00%
2	**N**	25	3	3	0	0	31
		80.60%	9.70%	9.70%	0.00%	0.00%	100.00%
3	**N**	23	4	4	5	3	39
		59.00%	10.30%	10.30%	12.80%	7.70%	100.00%
4	**N**	18	6	8	4	1	37
		48.60%	16.20%	21.60%	10.80%	2.70%	100.00%
5	**N**	12	4	5	5	1	27
		44.40%	14.80%	18.50%	18.50%	3.70%	100.00%
6	**N**	14	3	2	15	2	36
		38.90%	8.30%	5.60%	41.70%	5.60%	100.00%
7	**N**	20	4	11	10	0	45
		44.40%	8.90%	24.40%	22.20%	0.00%	100.00%
8	**N**	16	3	11	5	3	38
		42.10%	7.90%	28.90%	13.20%	7.90%	100.00%
Total	**N**	**152**	**28**	**46**	**44**	**10**	**280**
		54.30%	**10.00%**	**16.40%**	**15.70%**	**3.60%**	**100.00%**

Table II.9: Number (N) and percentages (%) of teeth present and observable, and with pulp, dentine, and enamel lesions in **low SES** individuals from **Athens**.

		Not affected	Pulp lesions	Dentine lesions	Fillings	Enamel lesions	Total
1	**N**	14	1	1	0	2	18
		77.80%	5.60%	5.60%	0.00%	11.10%	100.00%
2	**N**	15	0	2	2	3	22
		68.20%	0.00%	9.10%	9.10%	13.60%	100.00%
3	**N**	27	2	0	1	1	31
		87.10%	6.50%	0.00%	3.20%	3.20%	100.00%
4	**N**	13	3	0	6	1	23
		56.50%	13.00%	0.00%	26.10%	4.30%	100.00%
5	**N**	12	0	2	5	0	19
		63.20%	0.00%	10.50%	26.30%	0.00%	100.00%
6	**N**	5	2	3	13	0	23
		21.70%	8.70%	13.00%	56.50%	0.00%	100.00%
7	**N**	10	5	2	15	2	34
		29.40%	14.70%	5.90%	44.10%	5.90%	100.00%
8	**N**	5	7	1	8	0	21
		23.80%	33.30%	4.80%	38.10%	0.00%	100.00%
Total	**N**	**101**	**20**	**11**	**50**	**9**	**191**
		52.90%	**10.50%**	**5.80%**	**26.20%**	**4.70%**	**100.00%**

Table II.10: Number (N) and percentages (%) of teeth present and observable, and with pulp, dentine, and enamel lesions in **high SES** individuals from **Athens**.

		Slight wear	Moderate wear	Heavy wear	Total
1	**N**	28	151	159	338
		8.30%	44.70%	47.00%	100.00%
2	**N**	62	180	140	382
		16.20%	47.10%	36.60%	100.00%
3	**N**	76	272	171	519
		14.60%	52.40%	32.90%	100.00%
4	**N**	125	160	192	477
		26.20%	33.50%	40.30%	100.00%
5	**N**	97	142	199	438
		22.10%	32.40%	45.40%	100.00%
6	**N**	10	111	354	475
		2.10%	23.40%	74.50%	100.00%
7	**N**	44	175	253	472
		9.30%	37.10%	53.60%	100.00%
8	**N**	58	153	83	294
		19.70%	52.00%	28.20%	100.00%
Total	**N**	**500**	**1344**	**1551**	**3395**
		14.70%	**39.60%**	**45.70%**	**100.00%**

Table II.11: Number (N) and percentages (%) of teeth with slight, moderate and heavy wear in **Demetrias**.

		Slight wear	Moderate wear	Heavy wear	Total
1	**N**	40	43	7	90
		44.40%	47.80%	7.80%	100.00%
2	**N**	74	28	6	108
		68.50%	25.90%	5.60%	100.00%
3	**N**	111	40	7	158
		70.30%	25.30%	4.40%	100.00%
4	**N**	111	17	3	131
		84.70%	13.00%	2.30%	100.00%
5	**N**	85	16	3	104
		81.70%	15.40%	2.90%	100.00%
6	**N**	38	63	5	106
		35.80%	59.40%	4.70%	100.00%
7	**N**	79	62	1	142
		55.60%	43.70%	0.70%	100.00%
8	**N**	71	22	2	95
		74.70%	23.20%	2.10%	100.00%
Total	**N**	**609**	**291**	**34**	**934**
		65.20%	**31.20%**	**3.60%**	**100.00%**

Table II.12: Number (N) and percentages (%) of teeth with slight, moderate and heavy wear in **Athens**.

		Slight wear	Moderate wear	Heavy wear	Total
1	**N**	23	73	44	140
		16.40%	52.10%	31.40%	100.00%
2	**N**	44	82	38	164
		26.80%	50.00%	23.20%	100.00%
3	**N**	54	107	51	212
		25.50%	50.50%	24.10%	100.00%
4	**N**	75	65	58	198
		37.90%	32.80%	29.30%	100.00%
5	**N**	52	56	65	173
		30.10%	32.40%	37.60%	100.00%
6	**N**	10	52	135	197
		5.10%	26.40%	68.50%	100.00%
7	**N**	30	81	83	194
		15.50%	41.80%	42.80%	100.00%
8	**N**	37	62	22	121
		30.60%	51.20%	18.20%	100.00%
Total	**N**	**325**	**578**	**496**	**1399**
		23.20%	**41.30%**	**35.50%**	**100.00%**

Table II.13: Number (N) and percentages (%) of teeth with slight, moderate and heavy wear in **female** individuals **from Demetrias**.

		Slight wear	Moderate wear	Heavy wear	Total
1	**N**	5	78	115	198
		2.50%	39.40%	58.10%	100.00%
2	**N**	18	98	102	218
		8.30%	45.00%	46.80%	100.00%
3	**N**	22	165	120	307
		7.20%	53.70%	39.10%	100.00%
4	**N**	50	95	134	279
		17.90%	34.10%	48.00%	100.00%
5	**N**	45	86	134	265
		17.00%	32.50%	50.60%	100.00%
6	**N**	0	59	219	278
		0.00%	21.20%	78.80%	100.00%
7	**N**	14	94	170	278
		5.00%	33.80%	61.20%	100.00%
8	**N**	21	91	61	173
		12.10%	52.60%	35.30%	100.00%
Total	**N**	**175**	**766**	**1055**	**1996**
		8.80%	**38.40%**	**52.90%**	**100.00%**

Table II.14: Number (N) and percentages (%) of teeth with slight, moderate and heavy wear in **female** individuals **from Demetrias**.

		Slight wear	Moderate wear	Heavy wear	Total
1	**N**	18	14	3	35
		51.40%	40.00%	8.60%	100.00%
2	**N**	34	11	1	46
		73.90%	23.90%	2.20%	100.00%
3	**N**	55	10	2	67
		82.10%	14.90%	3.00%	100.00%
4	**N**	41	5	1	47
		87.20%	10.60%	2.10%	100.00%
5	**N**	39	5	0	44
		88.60%	11.40%	0.00%	100.00%
6	**N**	17	35	1	53
		32.10%	66.00%	1.90%	100.00%
7	**N**	37	29	0	66
		56.10%	43.90%	0.00%	100.00%
8	**N**	32	7	0	39
		82.10%	17.90%	0.00%	100.00%
Total	**N**	**273**	**116**	**8**	**397**
		68.80%	**29.20%**	**2.00%**	**100.00%**

Table II.15: Number (N) and percentages (%) of teeth with slight, moderate and heavy wear in **female** individuals **from Athens**.

		Slight wear	Moderate wear	Heavy wear	Total
1	**N**	22	29	4	55
		40.00%	52.70%	7.30%	100.00%
2	**N**	40	17	5	62
		64.50%	27.40%	8.10%	100.00%
3	**N**	56	30	5	91
		61.50%	33.00%	5.50%	100.00%
4	**N**	70	12	2	84
		83.30%	14.30%	2.40%	100.00%
5	**N**	46	11	3	60
		76.70%	18.30%	5.00%	100.00%
6	**N**	21	28	4	53
		39.60%	52.80%	7.50%	100.00%
7	**N**	42	33	1	76
		55.30%	43.40%	1.30%	100.00%
8	**N**	39	15	2	56
		69.60%	26.80%	3.60%	100.00%
Total	**N**	**336**	**175**	**26**	**537**
		62.60%	**32.60%**	**4.80%**	**100.00%**

Table II.16: Number (N) and percentages (%) of teeth with slight, moderate and heavy wear in **male** individuals **from Athens**.

		Slight wear	Moderate wear	Heavy wear	Total
1	**N**	11	71	78	160
		6.90%	44.40%	48.80%	100.00%
2	**N**	33	87	71	191
		17.30%	45.50%	37.20%	100.00%
3	**N**	38	139	90	267
		14.20%	52.10%	33.70%	100.00%
4	**N**	78	66	99	243
		32.10%	27.20%	40.70%	100.00%
5	**N**	64	56	107	227
		28.20%	24.70%	47.10%	100.00%
6	**N**	1	48	209	258
		0.40%	18.60%	81.00%	100.00%
7	**N**	19	86	155	260
		7.30%	33.10%	59.60%	100.00%
8	**N**	30	82	37	149
		20.10%	55.00%	24.80%	100.00%
Total	**N**	**274**	**635**	**846**	**1755**
		15.60%	**36.20%**	**48.20%**	**100.00%**

Table II.17: Number (N) and percentages (%) of teeth with slight, moderate and heavy wear in **low SES** individuals **from Demetrias**.

		Slight wear	Moderate wear	Heavy wear	Total
1	**N**	17	80	81	178
		9.60%	44.90%	45.50%	100.00%
2	**N**	29	93	69	191
		15.20%	48.70%	36.10%	100.00%
3	**N**	38	133	81	252
		15.10%	52.80%	32.10%	100.00%
4	**N**	47	94	93	234
		20.10%	40.20%	39.70%	100.00%
5	**N**	33	86	92	211
		15.60%	40.80%	43.60%	100.00%
6	**N**	9	63	145	217
		4.10%	29.00%	66.80%	100.00%
7	**N**	25	89	98	212
		11.80%	42.00%	46.20%	100.00%
8	**N**	28	71	46	145
		19.30%	49.00%	31.70%	100.00%
Total	**N**	**226**	**709**	**705**	**1640**
		13.80%	**43.20%**	**43.00%**	**100.00%**

Table II.18: Number (N) and percentages (%) of teeth with slight, moderate and heavy wear in **high SES** individuals **from Demetrias**.

		Slight wear	Moderate wear	Heavy wear	Total
1	**N**	17	5	4	26
		65.40%	19.20%	15.40%	100.00%
2	**N**	22	2	2	26
		84.60%	7.70%	7.70%	100.00%
3	**N**	24	5	2	31
		77.40%	16.10%	6.50%	100.00%
4	**N**	28	4	0	32
		87.50%	12.50%	0.00%	100.00%
5	**N**	15	3	0	18
		83.30%	16.70%	0.00%	100.00%
6	**N**	7	8	3	18
		38.90%	44.40%	16.70%	100.00%
7	**N**	12	13	1	26
		46.20%	50.00%	3.80%	100.00%
8	**N**	20	11	0	31
		64.50%	35.50%	0.00%	100.00%
Total	**N**	**145**	**51**	**12**	**208**
		69.70%	**24.50%**	**5.80%**	**100.00%**

Table II.19: Number (N) and percentages (%) of teeth with slight, moderate and heavy wear in **low SES** individuals **from Athens**.

		Slight wear	Moderate wear	Heavy wear	Total
1	**N**	1	15	0	16
		6.30%	93.80%	0.00%	100.00%
2	**N**	7	10	1	18
		38.90%	55.60%	5.60%	100.00%
3	**N**	14	16	0	30
		46.70%	53.30%	0.00%	100.00%
4	**N**	12	3	1	16
		75.00%	18.80%	6.30%	100.00%
5	**N**	10	3	2	15
		66.70%	20.00%	13.30%	100.00%
6	**N**	1	8	0	9
		11.10%	88.90%	0.00%	100.00%
7	**N**	3	14	0	17
		17.60%	82.40%	0.00%	100.00%
8	**N**	6	1	1	8
		75.00%	12.50%	12.50%	100.00%
Total	**N**	**54**	**70**	**5**	**129**
		41.90%	**54.30%**	**3.90%**	**100.00%**

Table II.20: Number (N) and percentages (%) of teeth with slight, moderate and heavy wear in **high SES** individuals **from Athens**.

		Healthy	Gingivitis	Acute burst	Quiescent	Progressive	Total
8-7	**N**	25	11	13	4	0	53
		47.20%	20.80%	24.50%	7.50%	0.00%	100.00%
7-6	**N**	21	11	19	2	0	53
		39.60%	20.80%	35.80%	3.80%	0.00%	100.00%
6-5	**N**	13	11	21	3	0	48
		27.10%	22.90%	43.80%	6.30%	0.00%	100.00%
5-4	**N**	12	12	22	4	0	50
		24.00%	24.00%	44.00%	8.00%	0.00%	100.00%
4-3	**N**	5	9	20	1	0	35
		14.30%	25.70%	57.10%	2.90%	0.00%	100.00%
3-2	**N**	5	7	13	1	0	26
		19.20%	26.90%	50.00%	3.80%	0.00%	100.00%
2-1	**N**	5	5	12	1	0	23
		21.70%	21.70%	52.20%	4.30%	0.00%	100.00%
1-1	**N**	5	5	9	0	0	19
		26.30%	26.30%	47.40%	0.00%	0.00%	100.00%
1-2	**N**	5	5	10	2	0	22
		22.70%	22.70%	45.50%	9.10%	0.00%	100.00%
2-3	**N**	6	5	14	3	0	28
		21.40%	17.90%	50.00%	10.70%	0.00%	100.00%
3-4	**N**	8	8	19	3	0	38
		21.10%	21.10%	50.00%	7.90%	0.00%	100.00%
4-5	**N**	14	10	22	5	0	51
		27.50%	19.60%	43.10%	9.80%	0.00%	100.00%
5-6	**N**	17	12	16	5	0	50
		34.00%	24.00%	32.00%	10.00%	0.00%	100.00%
6-7	**N**	23	9	11	4	1	48
		47.90%	18.80%	22.90%	8.30%	2.10%	100.00%
7-8	**N**	18	8	9	4	1	40
		45.00%	20.00%	22.50%	10.00%	2.50%	100.00%
	N	**182**	**128**	**230**	**42**	**2**	**584**
		31.20%	**21.90%**	**39.40%**	**7.20%**	**0.30%**	**100.00%**

Table II.21: Number (N) and percentages (%) of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis in **Demetrias**.

		Healthy	Gingivitis	Acute burst	Quiescent	Progressive	Total
8-7	**N**	3	21	15	3	2	44
		6.80%	47.70%	34.10%	6.80%	4.50%	100.00%
7-6	**N**	4	34	18	5	2	63
		6.30%	54.00%	28.60%	7.90%	3.20%	100.00%
6-5	**N**	4	27	30	4	0	65
		6.20%	41.50%	46.20%	6.20%	0.00%	100.00%
5-4	**N**	4	32	51	1	0	88
		4.50%	36.40%	58.00%	1.10%	0.00%	100.00%
4-3	**N**	4	39	68	2	0	113
		3.50%	34.50%	60.20%	1.80%	0.00%	100.00%
3-2	**N**	7	31	89	2	0	129
		5.40%	24.00%	69.00%	1.60%	0.00%	100.00%
2-1	**N**	7	28	91	2	0	128
		5.50%	21.90%	71.10%	1.60%	0.00%	100.00%
1-1	**N**	8	28	90	2	0	128
		6.30%	21.90%	70.30%	1.60%	0.00%	100.00%
1-2	**N**	6	30	85	1	0	122
		4.90%	24.60%	69.70%	0.80%	0.00%	100.00%
2-3	**N**	6	33	82	1	0	122
		4.90%	27.00%	67.20%	0.80%	0.00%	100.00%
3-4	**N**	6	32	63	1	1	103
		5.80%	31.10%	61.20%	1.00%	1.00%	100.00%
4-5	**N**	6	29	46	1	0	82
		7.30%	35.40%	56.10%	1.20%	0.00%	100.00%
5-6	**N**	3	30	31	3	0	67
		4.50%	44.80%	46.30%	4.50%	0.00%	100.00%
6-7	**N**	4	37	23	4	0	68
		5.90%	54.40%	33.80%	5.90%	0.00%	100.00%
7-8	**N**	5	22	16	3	1	47
		10.60%	46.80%	34.00%	6.40%	2.10%	100.00%
Total	**N**	**77**	**453**	**798**	**35**	**6**	**1369**
		5.60%	**33.10%**	**58.30%**	**2.60%**	**0.40%**	**100.00%**

Table II.22: Number (N) and percentages (%) of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis in **Athens**.

		Healthy	Gingivitis	Acute burst	Quiescent	Total
8-7	**N**	9	3	8	0	20
		45.00%	15.00%	40.00%	0.00%	100.00%
7-6	**N**	8	5	10	0	23
		34.80%	21.70%	43.50%	0.00%	100.00%
6-5	**N**	5	6	10	0	21
		23.80%	28.60%	47.60%	0.00%	100.00%
5-4	**N**	4	7	9	0	20
		20.00%	35.00%	45.00%	0.00%	100.00%
4-3	**N**	3	6	9	0	18
		16.70%	33.30%	50.00%	0.00%	100.00%
3-2	**N**	2	4	7	0	13
		15.40%	30.80%	53.80%	0.00%	100.00%
2-1	**N**	2	3	6	0	11
		18.20%	27.30%	54.50%	0.00%	100.00%
1-1	**N**	2	3	4	0	9
		22.20%	33.30%	44.40%	0.00%	100.00%
1-2	**N**	2	3	5	0	10
		20.00%	30.00%	50.00%	0.00%	100.00%
2-3	**N**	3	3	8	0	14
		21.40%	21.40%	57.10%	0.00%	100.00%
3-4	**N**	3	5	11	0	19
		15.80%	26.30%	57.90%	0.00%	100.00%
4-5	**N**	4	5	10	1	20
		20.00%	25.00%	50.00%	5.00%	100.00%
5-6	**N**	6	5	9	3	23
		26.10%	21.70%	39.10%	13.00%	100.00%
6-7	**N**	8	4	7	1	20
		40.00%	20.00%	35.00%	5.00%	100.00%
7-8	**N**	5	2	6	0	13
		38.50%	15.40%	46.20%	0.00%	100.00%
Total	**N**	**66**	**64**	**119**	**5**	**254**
		26.00%	**25.20%**	**46.90%**	**2.00%**	**100.00%**

Table II.23: Number (N) and percentages (%) of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis in **female** individuals from **Demetrias**.

		Healthy	Gingivitis	Acute burst	Quiescent	Progressive	Total
8-7	**N**	16	8	5	4	0	33
		48.50%	24.20%	15.20%	12.10%	0.00%	100.00%
7-6	**N**	13	6	9	2	0	30
		43.30%	20.00%	30.00%	6.70%	0.00%	100.00%
6-5	**N**	8	5	11	3	0	27
		29.60%	18.50%	40.70%	11.10%	0.00%	100.00%
5-4	**N**	8	5	13	4	0	30
		26.70%	16.70%	43.30%	13.30%	0.00%	100.00%
4-3	**N**	2	3	11	1	0	17
		11.80%	17.60%	64.70%	5.90%	0.00%	100.00%
3-2	**N**	3	3	6	1	0	13
		23.10%	23.10%	46.20%	7.70%	0.00%	100.00%
2-1	**N**	3	2	6	1	0	12
		25.00%	16.70%	50.00%	8.30%	0.00%	100.00%
1-1	**N**	3	2	5	0	0	10
		30.00%	20.00%	50.00%	0.00%	0.00%	100.00%
1-2	**N**	3	2	5	2	0	12
		25.00%	16.70%	41.70%	16.70%	0.00%	100.00%
2-3	**N**	3	2	6	3	0	14
		21.40%	14.30%	42.90%	21.40%	0.00%	100.00%
3-4	**N**	5	3	8	3	0	19
		26.30%	15.80%	42.10%	15.80%	0.00%	100.00%
4-5	**N**	10	5	12	4	0	31
		32.30%	16.10%	38.70%	12.90%	0.00%	100.00%
5-6	**N**	11	7	7	2	0	27
		40.70%	25.90%	25.90%	7.40%	0.00%	100.00%
6-7	**N**	15	5	4	3	1	28
		53.60%	17.90%	14.30%	10.70%	3.60%	100.00%
7-8	**N**	13	6	3	4	1	27
		48.10%	22.20%	11.10%	14.80%	3.70%	100.00%
	N	**116**	**64**	**111**	**37**	**2**	**330**
		35.20%	**19.40%**	**33.60%**	**11.20%**	**0.60%**	**100.00%**

Table II.24: Number (N) and percentages (%) of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis in **male** individuals from **Demetrias**.

		Healthy	Gingivitis	Acute burst	Quiescent	Progressive	Total
8-7	**N**	2	12	4	0	1	19
		10.50%	63.20%	21.10%	0.00%	5.30%	100.00%
7-6	**N**	2	17	10	1	1	31
		6.50%	54.80%	32.30%	3.20%	3.20%	100.00%
6-5	**N**	3	13	19	0	0	35
		8.60%	37.10%	54.30%	0.00%	0.00%	100.00%
5-4	**N**	3	13	27	0	0	43
		7.00%	30.20%	62.80%	0.00%	0.00%	100.00%
4-3	**N**	3	15	33	1	0	52
		5.80%	28.80%	63.50%	1.90%	0.00%	100.00%
3-2	**N**	4	10	43	1	0	58
		6.90%	17.20%	74.10%	1.70%	0.00%	100.00%
2-1	**N**	5	9	44	1	0	59
		8.50%	15.30%	74.60%	1.70%	0.00%	100.00%
1-1	**N**	6	10	46	1	0	63
		9.50%	15.90%	73.00%	1.60%	0.00%	100.00%
1-2	**N**	4	10	45	1	0	60
		6.70%	16.70%	75.00%	1.70%	0.00%	100.00%
2-3	**N**	4	12	43	1	0	60
		6.70%	20.00%	71.70%	1.70%	0.00%	100.00%
3-4	**N**	4	11	31	1	0	47
		8.50%	23.40%	66.00%	2.10%	0.00%	100.00%
4-5	**N**	4	11	26	1	0	42
		9.50%	26.20%	61.90%	2.40%	0.00%	100.00%
5-6	**N**	2	13	18	2	0	35
		5.70%	37.10%	51.40%	5.70%	0.00%	100.00%
6-7	**N**	3	16	13	1	0	33
		9.10%	48.50%	39.40%	3.00%	0.00%	100.00%
7-8	**N**	3	13	7	0	0	23
		13.00%	56.50%	30.40%	0.00%	0.00%	100.00%
Total	**N**	**52**	**185**	**409**	**12**	**2**	**660**
		7.90%	**28.00%**	**62.00%**	**1.80%**	**0.30%**	**100.00%**

Table II.25: Number (N) and percentages (%) of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis in **female** individuals from **Athens**.

		Healthy	Gingivitis	Acute burst	Quiescent	Progressive	
8-7	**N**	1	9	11	3	1	25
		4.00%	36.00%	44.00%	12.00%	4.00%	100.00%
7-6	**N**	2	17	8	4	1	32
		6.30%	53.10%	25.00%	12.50%	3.10%	100.00%
6-5	**N**	1	14	11	4	0	30
		3.30%	46.70%	36.70%	13.30%	0.00%	100.00%
5-4	**N**	1	19	24	1	0	45
		2.20%	42.20%	53.30%	2.20%	0.00%	100.00%
4-3	**N**	1	24	35	1	0	61
		1.60%	39.30%	57.40%	1.60%	0.00%	100.00%
3-2	**N**	3	21	46	1	0	71
		4.20%	29.60%	64.80%	1.40%	0.00%	100.00%
2-1	**N**	2	19	47	1	0	69
		2.90%	27.50%	68.10%	1.40%	0.00%	100.00%
1-1	**N**	2	18	44	1	0	65
		3.10%	27.70%	67.70%	1.50%	0.00%	100.00%
1-2	**N**	2	20	40	0	0	62
		3.20%	32.30%	64.50%	0.00%	0.00%	100.00%
2-3	**N**	2	21	39	0	0	62
		3.20%	33.90%	62.90%	0.00%	0.00%	100.00%
3-4	**N**	2	21	32	0	1	56
		3.60%	37.50%	57.10%	0.00%	1.80%	100.00%
4-5	**N**	2	18	20	0	0	40
		5.00%	45.00%	50.00%	0.00%	0.00%	100.00%
5-6	**N**	1	17	13	1	0	32
		3.10%	53.10%	40.60%	3.10%	0.00%	100.00%
6-7	**N**	1	21	10	3	0	35
		2.90%	60.00%	28.60%	8.60%	0.00%	100.00%
7-8	**N**	2	9	9	3	1	24
		8.30%	37.50%	37.50%	12.50%	4.20%	100.00%
	N	**25**	**268**	**389**	**23**	**4**	**709**
		3.50%	**37.80%**	**54.90%**	**3.20%**	**0.60%**	**100.00%**

Table II.26: Number (N) and percentages (%) of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis in **male** individuals from **Athens**.

		Healthy	Gingivitis	Acute burst	Quiescent	Progressive	Total
8-7	**N**	9	3	9	2	0	23
		39.10%	13.00%	39.10%	8.70%	0.00%	100.00%
7-6	**N**	8	3	13	2	0	26
		30.80%	11.50%	50.00%	7.70%	0.00%	100.00%
6-5	**N**	5	2	17	3	0	27
		18.50%	7.40%	63.00%	11.10%	0.00%	100.00%
5-4	**N**	5	3	19	3	0	30
		16.70%	10.00%	63.30%	10.00%	0.00%	100.00%
4-3	**N**	0	2	18	1	0	21
		0.00%	9.50%	85.70%	4.80%	0.00%	100.00%
3-2	**N**	0	0	12	1	0	13
		0.00%	0.00%	92.30%	7.70%	0.00%	100.00%
2-1	**N**	0	0	11	1	0	12
		0.00%	0.00%	91.70%	8.30%	0.00%	100.00%
1-1	**N**	0	0	8	0	0	8
		0.00%	0.00%	100.00%	0.00%	0.00%	100.00%
1-2	**N**	0	0	9	1	0	10
		0.00%	0.00%	90.00%	10.00%	0.00%	100.00%
2-3	**N**	1	0	13	2	0	16
		6.30%	0.00%	81.30%	12.50%	0.00%	100.00%
3-4	**N**	2	3	18	2	0	25
		8.00%	12.00%	72.00%	8.00%	0.00%	100.00%
4-5	**N**	7	4	20	3	0	34
		20.60%	11.80%	58.80%	8.80%	0.00%	100.00%
5-6	**N**	7	4	13	2	0	26
		26.90%	15.40%	50.00%	7.70%	0.00%	100.00%
6-7	**N**	8	4	8	2	1	23
		34.80%	17.40%	34.80%	8.70%	4.30%	100.00%
7-8	**N**	7	3	5	2	1	18
		38.90%	16.70%	27.80%	11.10%	5.60%	100.00%
Total	**N**	**59**	**31**	**193**	**27**	**2**	**312**
		18.90%	**9.90%**	**61.90%**	**8.70%**	**0.60%**	**100.00%**

Table II.27: Number (N) and percentages (%) of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis in **low SES** individuals from **Demetrias**.

		Healthy	Gingivitis	Acute burst	Quiescent	Total
8-7	**N**	16	8	4	2	30
		53.30%	26.70%	13.30%	6.70%	100.00%
7-6	**N**	13	8	6	0	27
		48.10%	29.60%	22.20%	0.00%	100.00%
6-5	**N**	8	9	4	0	21
		38.10%	42.90%	19.00%	0.00%	100.00%
5-4	**N**	7	9	3	1	20
		35.00%	45.00%	15.00%	5.00%	100.00%
4-3	**N**	5	7	2	0	14
		35.70%	50.00%	14.30%	0.00%	100.00%
3-2	**N**	5	7	1	0	13
		38.50%	53.80%	7.70%	0.00%	100.00%
2-1	**N**	5	5	1	0	11
		45.50%	45.50%	9.10%	0.00%	100.00%
1-1	**N**	5	5	1	0	11
		45.50%	45.50%	9.10%	0.00%	100.00%
1-2	**N**	5	5	1	1	12
		41.70%	41.70%	8.30%	8.30%	100.00%
2-3	**N**	5	5	1	1	12
		41.70%	41.70%	8.30%	8.30%	100.00%
3-4	**N**	6	5	1	1	13
		46.20%	38.50%	7.70%	7.70%	100.00%
4-5	**N**	7	6	2	2	17
		41.20%	35.30%	11.80%	11.80%	100.00%
5-6	**N**	10	8	3	3	24
		41.70%	33.30%	12.50%	12.50%	100.00%
6-7	**N**	15	5	3	2	25
		60.00%	20.00%	12.00%	8.00%	100.00%
7-8	**N**	11	5	4	2	22
		50.00%	22.70%	18.20%	9.10%	100.00%
Total	**N**	**123**	**97**	**37**	**15**	**272**
		45.20%	**35.70%**	**13.60%**	**5.50%**	**100.00%**

Table II.28: Number (N) and percentages (%) of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis in **high SES** individuals from **Demetrias**.

		Healthy	Gingivitis	Acute burst	Quiescent	Progressive	Total
8-7	**N**	0	8	3	1	0	12
		0.00%	66.70%	25.00%	8.30%	0.00%	100.00%
7-6	**N**	1	9	3	1	0	14
		7.10%	64.30%	21.40%	7.10%	0.00%	100.00%
6-5	**N**	0	6	1	2	0	9
		0.00%	66.70%	11.10%	22.20%	0.00%	100.00%
5-4	**N**	0	6	7	1	0	14
		0.00%	42.90%	50.00%	7.10%	0.00%	100.00%
4-3	**N**	1	8	11	1	0	21
		4.80%	38.10%	52.40%	4.80%	0.00%	100.00%
3-2	**N**	1	8	14	1	0	24
		4.20%	33.30%	58.30%	4.20%	0.00%	100.00%
2-1	**N**	1	6	15	1	0	23
		4.30%	26.10%	65.20%	4.30%	0.00%	100.00%
1-1	**N**	1	6	14	1	0	22
		4.50%	27.30%	63.60%	4.50%	0.00%	100.00%
1-2	**N**	1	8	13	0	0	22
		4.50%	36.40%	59.10%	0.00%	0.00%	100.00%
2-3	**N**	1	8	12	0	0	21
		4.80%	38.10%	57.10%	0.00%	0.00%	100.00%
3-4	**N**	0	8	9	0	0	17
		0.00%	47.10%	52.90%	0.00%	0.00%	100.00%
4-5	**N**	0	8	8	0	0	16
		0.00%	50.00%	50.00%	0.00%	0.00%	100.00%
5-6	**N**	0	8	5	0	0	13
		0.00%	61.50%	38.50%	0.00%	0.00%	100.00%
6-7	**N**	0	10	4	1	0	15
		0.00%	66.70%	26.70%	6.70%	0.00%	100.00%
7-8	**N**	0	6	4	1	1	12
		0.00%	50.00%	33.30%	8.30%	8.30%	100.00%
Total	**N**	**7**	**113**	**123**	**11**	**1**	**255**
		2.70%	**44.30%**	**48.20%**	**4.30%**	**0.40%**	**100.00%**

Table II.29: Number (N) and percentages (%) of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis in **low SES** individuals from **Athens**.

		Healthy	Gingivitis	Acute burst	Quiescent	Progressive	Total
8-7	**N**	1	0	2	0	1	4
		25.00%	0.00%	50.00%	0.00%	25.00%	100.00%
7-6	**N**	0	2	2	1	1	6
		0.00%	33.30%	33.30%	16.70%	16.70%	100.00%
6-5	**N**	0	3	5	1	0	9
		0.00%	33.30%	55.60%	11.10%	0.00%	100.00%
5-4	**N**	0	4	10	0	0	14
		0.00%	28.60%	71.40%	0.00%	0.00%	100.00%
4-3	**N**	0	6	11	0	0	17
		0.00%	35.30%	64.70%	0.00%	0.00%	100.00%
3-2	**N**	1	6	13	0	0	20
		5.00%	30.00%	65.00%	0.00%	0.00%	100.00%
2-1	**N**	0	7	12	0	0	19
		0.00%	36.80%	63.20%	0.00%	0.00%	100.00%
1-1	**N**	0	6	12	0	0	18
		0.00%	33.30%	66.70%	0.00%	0.00%	100.00%
1-2	**N**	0	6	11	0	0	17
		0.00%	35.30%	64.70%	0.00%	0.00%	100.00%
2-3	**N**	0	6	11	0	0	17
		0.00%	35.30%	64.70%	0.00%	0.00%	100.00%
3-4	**N**	0	7	7	0	1	15
		0.00%	46.70%	46.70%	0.00%	6.70%	100.00%
4-5	**N**	0	3	3	0	0	6
		0.00%	50.00%	50.00%	0.00%	0.00%	100.00%
5-6	**N**	0	3	3	0	0	6
		0.00%	50.00%	50.00%	0.00%	0.00%	100.00%
6-7	**N**	0	4	1	1	0	6
		0.00%	66.70%	16.70%	16.70%	0.00%	100.00%
7-8	**N**	0	1	1	0	0	2
		0.00%	50.00%	50.00%	0.00%	0.00%	100.00%
Total	**N**	**2**	**64**	**104**	**3**	**3**	**176**
		1.10%	**36.40%**	**59.10%**	**1.70%**	**1.70%**	**100.00%**

Table II.30: Number (N) and percentages (%) of interseptal areas with gingivitis, acute burst, quiescent phase and progressive periodontitis in **high SES** individuals from **Athens**.

		Not affected	DDE	Total
1	**N**	65	62	127
		51.20%	48.80%	100.00%
2	**N**	77	57	134
		57.50%	42.50%	100.00%
3	**N**	93	118	211
		44.10%	55.90%	100.00%
4	**N**	120	69	189
		63.50%	36.50%	100.00%
5	**N**	118	47	165
		71.50%	28.50%	100.00%
6	**N**	129	30	159
		81.10%	18.90%	100.00%
7	**N**	132	26	158
		83.50%	16.50%	100.00%
8	**N**	112	6	118
		94.90%	5.10%	100.00%
Total	**N**	**846**	**415**	**1261**
		67.10%	**32.90%**	**100.00%**

Table II.31: Number (N) and percentages (%) of teeth with furrow-like and pit defects of enamel, in **Demetrias**.

		Not affected	DDE	Total
1	**N**	51	37	88
		58.00%	42.00%	100.00%
2	**N**	66	35	101
		65.30%	34.70%	100.00%
3	**N**	86	58	144
		59.70%	40.30%	100.00%
4	**N**	85	25	110
		77.30%	22.70%	100.00%
5	**N**	77	18	95
		81.10%	18.90%	100.00%
6	**N**	115	14	129
		89.10%	10.90%	100.00%
7	**N**	138	9	147
		93.90%	6.10%	100.00%
8	**N**	80	0	80
		100.00%	0.00%	100.00%
Total	**N**	**698**	**196**	**894**
		78.10%	**21.90%**	**100.00%**

Table II.32: Number (N) and percentages (%) of teeth with furrow-like and pit defects of enamel in **Athens**.

		Not affected	DDE	Total
1	**N**	21	25	46
		45.70%	54.30%	100.00%
2	**N**	25	20	45
		55.60%	44.40%	100.00%
3	**N**	36	37	73
		49.30%	50.70%	100.00%
4	**N**	40	30	70
		57.10%	42.90%	100.00%
5	**N**	37	20	57
		64.90%	35.10%	100.00%
6	**N**	52	15	67
		77.60%	22.40%	100.00%
7	**N**	54	9	63
		85.70%	14.30%	100.00%
8	**N**	39	4	43
		90.70%	9.30%	100.00%
Total	**N**	**304**	**160**	**464**
		65.50%	**34.50%**	**100.00%**

Table II.33: Number (N) and percentages (%) of teeth with furrow-like and pit defects of enamel in **female** individuals from **Demetrias**.

		Not affected	DDE	Total
1	**N**	44	37	81
		54.30%	45.70%	100.00%
2	**N**	52	37	89
		58.40%	41.60%	100.00%
3	**N**	57	81	138
		41.30%	58.70%	100.00%
4	**N**	80	39	119
		67.20%	32.80%	100.00%
5	**N**	81	27	108
		75.00%	25.00%	100.00%
6	**N**	77	15	92
		83.70%	16.30%	100.00%
7	**N**	78	17	95
		82.10%	17.90%	100.00%
8	**N**	73	2	75
		97.30%	2.70%	100.00%
Total	**N**	**542**	**255**	**797**
		68.00%	**32.00%**	**100.00%**

Table II.34: Number (N) and percentages (%) of teeth with furrow-like and pit defects of enamel in **male** individuals from **Demetrias**.

		Not affected	DDE	Total
1	**N**	24	11	35
		68.60%	31.40%	100.00%
2	**N**	29	13	42
		69.00%	31.00%	100.00%
3	**N**	44	22	66
		66.70%	33.30%	100.00%
4	**N**	34	8	42
		81.00%	19.00%	100.00%
5	**N**	31	7	38
		81.60%	18.40%	100.00%
6	**N**	60	3	63
		95.20%	4.80%	100.00%
7	**N**	66	3	69
		95.70%	4.30%	100.00%
8	**N**	31	0	31
		100.00%	0.00%	100.00%
Total	**N**	**319**	**67**	**386**
		82.60%	**17.40%**	**100.00%**

Table II.35: Number (N) and percentages (%) of teeth with furrow-like and pit defects of enamel in **female** individuals from **Athens**.

		Not affected	DDE	Total
1	**N**	27	26	53
		50.90%	49.10%	100.00%
2	**N**	37	22	59
		62.70%	37.30%	100.00%
3	**N**	42	36	78
		53.80%	46.20%	100.00%
4	**N**	51	17	68
		75.00%	25.00%	100.00%
5	**N**	46	11	57
		80.70%	19.30%	100.00%
6	**N**	55	11	66
		83.30%	16.70%	100.00%
7	**N**	72	6	78
		92.30%	7.70%	100.00%
8	**N**	49	0	49
		100.00%	0.00%	100.00%
Total	**N**	**379**	**129**	**508**
		74.60%	**25.40%**	**100.00%**

Table II.36: Number (N) and percentages (%) of teeth with furrow-like and pit defects of enamel in **male** individuals from **Athens**.

		Not affected	DDE	Total
1	**N**	9	38	47
		19.10%	80.90%	100.00%
2	**N**	14	35	49
		28.60%	71.40%	100.00%
3	**N**	16	75	91
		17.60%	82.40%	100.00%
4	**N**	28	39	67
		41.80%	58.20%	100.00%
5	**N**	31	28	59
		52.50%	47.50%	100.00%
6	**N**	34	20	54
		63.00%	37.00%	100.00%
7	**N**	37	13	50
		74.00%	26.00%	100.00%
8	**N**	30	6	36
		83.30%	16.70%	100.00%
Total	**N**	**199**	**254**	**453**
		43.90%	**56.10%**	**100.00%**

Table II.37: Number (N) and percentages (%) of teeth with furrow-like and pit defects of enamel in **low SES** individuals from **Demetrias**.

		Not affected	DDE	Total
1	**N**	56	24	80
		70.00%	30.00%	100.00%
2	**N**	63	22	85
		74.10%	25.90%	100.00%
3	**N**	77	43	120
		64.20%	35.80%	100.00%
4	**N**	92	30	122
		75.40%	24.60%	100.00%
5	**N**	87	19	106
		82.10%	17.90%	100.00%
6	**N**	95	10	105
		90.50%	9.50%	100.00%
7	**N**	95	13	108
		88.00%	12.00%	100.00%
8	**N**	82	0	82
		100.00%	0.00%	100.00%
Total	**N**	**647**	**161**	**808**
		80.10%	**19.90%**	**100.00%**

Table II.38: Number (N) and percentages (%) of teeth with furrow-like and pit defects of enamel in **high SES** individuals from **Demetrias**.

		Not affected	DDE	Total
1	**N**	7	16	23
		30.40%	69.60%	100.00%
2	**N**	9	13	22
		40.90%	59.10%	100.00%
3	**N**	11	15	26
		42.30%	57.70%	100.00%
4	**N**	19	4	23
		82.60%	17.40%	100.00%
5	**N**	14	2	16
		87.50%	12.50%	100.00%
6	**N**	23	1	24
		95.80%	4.20%	100.00%
7	**N**	27	0	27
		100.00%	0.00%	100.00%
8	**N**	27	0	27
		100.00%	0.00%	100.00%
Total	**N**	**137**	**51**	**188**
		72.90%	**27.10%**	**100.00%**

Table II.39: Number (N) and percentages (%) of teeth with furrow-like and pit defects of enamel in **low SES** individuals from **Athens**.

		Not affected	DDE	Total
1	**N**	9	7	16
		56.30%	43.80%	100.00%
2	**N**	13	6	19
		68.40%	31.60%	100.00%
3	**N**	16	10	26
		61.50%	38.50%	100.00%
4	**N**	11	2	13
		84.60%	15.40%	100.00%
5	**N**	10	4	14
		71.40%	28.60%	100.00%
6	**N**	10	4	14
		71.40%	28.60%	100.00%
7	**N**	13	2	15
		86.70%	13.30%	100.00%
8	**N**	7	0	7
		100.00%	0.00%	100.00%
Total	**N**	**89**	**35**	**124**
		71.80%	**28.20%**	**100.00%**

Table II.40: Number (N) and percentages (%) of teeth with furrow-like and pit defects of enamel in **high SES** individuals from **Athens**.

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