Caries and Periodontal Disease: Insights from Two US Populations Living a Century Apart

Erin K. Rose[a]/Alexandre R. Vieira[a]

Purpose: To compare caries experience and periodontal status between two US populations that lived a century apart.

Materials and Methods: The University of Pittsburgh, School of Dental Medicine possesses a collection of skulls that was organised in the first half of the 20th century. Those individuals are likely to have lived in the northeast United States during the late 19th century and the early 20th century. The present study measured caries and periodontal disease morbidity in the collection of skulls and compared the data with current prevalence rates of these diseases in the United States (from the third National Health and Nutrition Examination Survey 1988–94).

Results: Periodontal health appears to have improved since this population resided, over 150 years ago. On the other hand, Americans between the ages of 16 and 39 appear to have the same prevalence of caries as a group of individuals that lived 150 years ago.

Conclusions: The periodontal health of Americans has probably improved in the last 100 years. The individuals identified that were free of caries and periodontal disease among the group that lived during the 19th century may have some protective factor against these diseases.

Key words: dental caries, epidemiology, periodontitis

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The two most common, yet preventable, oral diseases, periodontal disease and dental caries, continue to persist and affect millions of people from both developed and developing countries. In America, periodontal disease is more common in men than women, and in African and Mexican Americans than Caucasians (Borrell and Papapanou, 2005). The prevalence and extent of periodontal disease and caries usually increases with age and most commonly affects people at the lowest socioeconomic levels (U.S. Department of Health and Human Services, 2000).

The prevalence and extent of periodontal disease in the United States was estimated in the third National Health and Nutrition Examination Survey 1988–94 (NHANES III). Of the dentate adults 30–90 years of age, 53.1% experience attachment loss ≥ 3 mm, 35% have periodontal disease, with 21.8% having mild periodontitis and 12.6% having a moderate or severe form. These percentages extrapolate to about 35.7 million Americans of age 30 and older with periodontal disease. About 56 million people have ≥ 3 mm of

[a] *Center for Craniofacial and Dental Genetics and Department of Oral Biology, University of Pittsburgh School of Dental Medicine, 3501 Terrace Street, Pittsburgh, PA, 15261, USA*

Correspondence: *Alexandre R. Vieira, Department Oral Biology, 614 Salk Hall, University of Pittsburgh School of Dental Medicine, 3501 Terrace Street, Pittsburgh, PA, 15261, USA. Tel: 412-383-8972. Fax: 412-624-3080. Email: arv11@dental.pitt.edu*

attachment loss in 33% of their remaining teeth, and 21 million with ≥ 5 mm attachment loss on at least one tooth surface (Albandar et al, 1999).

Dental caries is the most common chronic childhood disease, affecting 60–90% of school-aged children from industrialised countries. Among children in the US, more than 50% of 5–9-year-olds and 78% of 17-year-olds have at least one cavity or filling. Poor children have decayed, missing or filled teeth (DMFT) scores twice as high as children from middle and upper-class families. According to the World Oral Health Report of 2003, 12-year-olds in North and South America have the highest DMFT indices among the six World Health Organization (WHO) regions (World Health Organization, 2003).

Although the prevalence of caries and periodontal disease is still high, it is expected that the oral health of the American population improved during the last century. The University of Pittsburgh, School of Dental Medicine possesses a collection of skulls that was organised in the first half of the 20th century. Those individuals are likely to have lived in the northeast United States during the late 19th century and the early 20th century. The present study measured caries and periodontal disease morbidity in the collection of skulls and compared the data with current prevalence rates of these diseases in the United States. The results provide insights of how oral health has improved from the late 19th century to late 20th century in the United States.

MATERIALS AND METHODS

There are 100 skulls in the University of Pittsburgh, School of Dental Medicine's collection. The work in the present study was approved by the University of Pittsburgh's ethical committee. The official set of archives of the skulls was misplaced, so the first task was to compile a new set of records. All the information left were notes written actually in the skulls. Some had annotated gender and age. Most of them had an indication that they were acquired from a seller in New York City around the 1930s. That is an indication that these individuals lived in the east coast of the United States and were not from the higher classes otherwise they would have received proper burials.

First, the probable gender, age, and ethnicity were determined using various markers of the skulls. The eruption time of teeth was used only in estimating the age of the children. However, of 100 skulls, only six were children. Ectocranial suture status, open vs. closed, was used as an age estimator because most of the skulls were adults. Closed sutures are indicative of an individual greater than 40, whereas open sutures represent an individual less than 40 (Brothwell, 1981).

To distinguish the sex of the skeleton, general differences between the male and female skull were used. The male skull is generally larger, heavier, and less rounded (at the forehead). Also, muscular ridges, such as temporal lines, the frontal sinuses, the palate, the supra-orbital ridges and the teeth are often larger and more prominent in males. The mastoid process is more developed and the upper margin of the orbit is more rounded. The mandible is more robust and the ramus of the mandible is broader and longer in males with a better-developed coronoid process. The female skull tends to retain more of an adolescent form (Katzenberg and Saunders, 2002).

For determining the race, various nasal features are commonly used by forensic anthropologists in order to determine ancestry. Caucasians usually have a narrow and tall nasal opening, high nasal bone, a more prominent chin, and greater brow ridging. Asians commonly possess a medium and short nasal opening, low nasal bone, and more protruding jaw. Africans tend to have a wide and short nasal opening, medium nasal bone, and an oblong orbital shape (National Library of Medicine, 2006).

The skulls were assessed for several dental characteristics or anomalies including: dental caries, periodontal loss, abscesses, ante-mortem tooth loss, dental calculus, enamel defects, malocclusion, abrasion, supernumerary teeth and tooth agenesis.

After assessing the oral condition, there were apparent trends of high occurrences of periodontal disease and caries among the skulls. Periodontal attachment loss measurements were taken from each skull to accurately determine the prevalence of mild, moderate and severe periodontal disease in this population of skulls. DMFT scores were calculated to determine the prevalence of caries experience. Table 1 describes caries and periodontal disease status of the study group.

In order to measure the severity of periodontal disease, each skull was examined with a periodontal probe to determine the amount of attachment loss. Each surface of the tooth was measured with the probe, but the measurement used for comparison was taken from the surface that showed the greatest attachment loss. In most instances it was the buccal surface. Attachment loss was recorded by measuring the surface from the edge of tooth at the cementum-enamel junction to the bottom of the bone line that has receded. Periodontal disease was classified as mild, moderate, and advanced (severe) with attachment

Table 1 Prevalence of caries and periodontal disease in the population of skulls categorised by gender and age

Skulls	N	Mean DMFT	Periodontal disease
Males	63		57
Females	31		28
Adults with estimated age above 40 years	52	4.0	47
Adults with estimated age under 40 years	42	4.1	38
Children	6	3.0	0
Total	100		85

Table 2 Periodontal disease status in the population of skulls according to gender and age

	Mild	Moderate	Severe	Healthy	Total
Male (Adults with estimated age above 40 years)	4	13	12	5	34
Female (Adults with estimated age above 40 years)	0	5	4	0	9
Male (Adults with estimated age under 40 years)	5	9	14	2	30
Female (Adults with estimated age under 40 years)	5	8	6	2	21
Children (unknown sex)	0	0	0	6	6
Total	14	35	36	15	100

loss measurements of 3–5mm, 5–7mm, and > 7mm, respectively. Measurements of 1–2 mm indicated no periodontal disease. Table 2 presents the distribution of the study group according to periodontal disease status.

The prevalence of caries morbidity and periodontal disease in this population was compared to a modern US population using chi-square statistics. The data from the US population sample was taken from NHANES III (National Center for Health Statistics, 1994). NHANES III data is taken from a multi-stage, stratified sample that is representative of the current US population.

NHANES III sampled the US population for periodontal disease and determined the differences in the prevalence among race, gender and age. Adults 40 and older from the skull population were compared with the US adults age 30 and older from NHANES III. All of the adults were categorised according to mild periodontitis, moderate/severe periodontitis, and no periodontitis (healthy). The group of skulls was compared to the total US population and to three different subgroups according to race including non-Hispanic Caucasians, non-Hispanic African Americans and Mexican Americans (Table 3).

The Kolmogorov-Smirnov test (KS-test) was used to determine if the prevalence of periodontitis among the skull population differed significantly from the groups within the US population (Kolmogorov, 1941; Smirnov, 1948). The KS-test was favourable to the present data because it is non-parametric and distribution free. The number of adults (age ≥ 30 for NHANES III and ≥ 40 for the skulls group) sampled for periodontal disease was 91, 6600, 2232, 1697, and 1455 from the skulls, the total US population, non-Hispanic Caucasians, non-Hispanic African Americans and Mexican Americans, respectively. Because the sample size of the study group was significantly smaller than the sample sizes of the other groups, the distribution of the absolute numbers was used. To find the distribution, the number of individuals within each category (mild, moderate/severe, and healthy) of each group (skulls, total US population, non-Hispanic Caucasians, non-Hispanic African Americans and Mexican Americans) was divided by the total number of individuals in that group. Once the distribution of periodontal disease for each group was found, the difference between the skulls and each US group was determined and divided by 100.

Table 3 A KS comparison of prevalence of periodontal disease among the population of skulls and the current US population

Group	Severity	Distribution	Difference	p-value
Skulls	Mild	0.1538		
	Moderate/Severe	0.7802		
	Healthy	0.6600		
All people (NHANES III)	Mild	0.1486	0.0052	NS
	Moderate/Severe	0.3304	0.4498	< 0.001
	Healthy	0.5209	0.4550	< 0.001
Caucasians (NHANES III)	Mild	0.1694	0.0156	NS
	Moderate/Severe	0.3427	0.4375	< 0.001
	Healthy	0.4879	0.4219	< 0.001
Africans (NHANES III)	Mild	0.2157	0.0619	NS
	Moderate/Severe	0.4313	0.3489	< 0.001
	Healthy	0.3530	0.2870	< 0.001
Mexicans (NHANES III)	Mild	0.1876	0.0338	NS
	Moderate/Severe	0.3794	0.4008	< 0.001
	Healthy	0.4330	0.3670	< 0.001

NS, not significant

Table 4 Dental caries data comparisons

Group	Total number	Number of people whose DMFT > 0 (%)	Mean DMFT	p-value (compared with skulls)
Skulls*	52	37 (71.15)	4.1	
16–19 years**	2161	1467 (67.89)	3.25	0.8294
20–39 years**	3162	2743 (86.76)	7.1	0.3592

Notes: * Includes ages < 40 years, excluding children; **Data from NHANES III 1999–2002.

RESULTS

Approximately half (n = 43) of the study group were older than 40 years of age. The male to female ratio was 2:1 (Table 1). Two thirds of the study group was defined as being of Caucasian ethnicity, whereas the remaining third was comprised of individuals of African and Asian descent.

The adult population presented a mean DMFT score of 4.0 (Table 1). Only nine adult individuals presented no signs of periodontal loss (less than 10%) (Table 2).

Table 3 shows that the individuals with mild periodontitis from the study group are not significantly different than individuals with mild periodontitis from all of the current US groups. There is a significantly larger proportion of moderate/severe individuals ($p < 0.001$) from the study group than any other NHANES III group and a significantly larger proportion of healthy individuals within the entire US population than the study group ($p < 0.001$).

DMFT scores of the study group of age 40 and under were compared to current population of 16–19-year-olds and 20–39-year olds from NHANES III data (Table 4). There were a total of 52 skulls age 40 and under, with 37 affected by caries with a DMFT > 0. Among the NHANES III population of 16–19-year-olds and 20–39-year-olds, 67.89% (1467) and 86.76% (2743), respectively, had a DMFT > 0. The results show the study group is not statistically different than the current population of 16–19-year-olds ($p = 0.83$) and 20–39-year-olds ($p = 0.36$).

DISCUSSION

The skulls studied were from an American population living in the 19th century, before the discovery of penicillin (1928) and prior to the era of advanced dental care. During this time, dental procedures were limited to extractions, primarily due to an infected or damaged tooth. Periodontal disease was prevalent because oral hygiene practices were not commonly performed. Dental procedures were mostly carried out by barbers and general physicians, in which they only performed extractions in order to alleviate the pain and remove the infected tooth (American Dental Association, 2005). All these historical facts indicate that differences in demographics between a group of individuals that lived in the United States 150 years ago and the current American population are not likely to be significant compared to the lack of preventive dentistry and its effect on oral health.

It has been suggested that a raised awareness of oral hygiene over the past decades has caused a reduction in the prevalence of dental caries (Keene, 1981; CDC, 1999; CDC, 2003). However, our results indicate that the caries status of Americans today appears to be no different than of a group of individuals that lived more than 100 years ago. Moreover, it is likely that these skulls are from a group of indigent people that did not have family to claim their remains, suggesting they are of a lower socioeconomic status for the time they lived. The NHANES III data suggests that caries prevalence is higher among those with lower socioeconomic status.

Whereas the prevalence of mild periodontitis was found to be no different between the study group that lived more than 100 years ago and the modern day American, severe and advanced forms of periodontal disease are significantly less common in the current US population. It is likely that an increased awareness of and access to oral health in the US contributed to a higher number of periodontally healthy Americans.

The skulls without flesh allow a much more precise analysis of bone loss than could ever be accomplished either with an oral examination or a radiographic analysis. Although it was impossible to control for inter-examiner differences in the present analysis, these differences probably did not play a major role in the results.

Although possible, it is unlikely that dietary habits or practices of oral hygiene were responsible for the healthy appearance of teeth and periodontal tissues of individuals in the skull group. Since periodontitis was a highly prevalent disease during the time the individuals of the present study group lived, one can infer that the healthy skulls were from individuals somehow protected against periodontal disease. The difference seen in the amount of healthy and severely affected people between the present study group and the NHANES III data can be attributed to better dentistry.

Individuals living more than 100 years ago and belonging to a lower income class would probably have similar dietary habits (diets rich in refined sugar and no preventive dental care). Therefore, variations in caries rates may be attributed to genetic composition of the individual and not just environmental factors. Caries-free individuals may be genetically protected against the disease, whereas those who experience a high caries rate are more genetically susceptible.

It should be noted that the group of skulls used in the present study is not representative of the North American population in the 19th century. Therefore, no generalisable conclusions can be drawn. However, the present study provides new and unique insights into two oral conditions that are still serious public health problems worldwide.

Several reports indicate that the oral health status of Americans has improved dramatically in the past several decades (Keene, 1981; CDC, 1999; CDC, 2003). However, oral diseases still can be considered a 'silent epidemic' because they affect the most vulnerable and lowest socioeconomic subgroups within society, and remain unnoticed by the majority of Americans (US Department of Health and Human Services, 2000). Caries and periodontal disease are treatable and preventable, but they continue to affect a large proportion of the US.

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