Periodontal Health Status in a Cohort of Young US Navy Personnel

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Abstract

Objectives: *Neither the prevalence of periodontal disease nor long-term trends in periodontal health among US military personnel has been well studied. The authors analyzed dental records to assess the prevalence and severity of periodontal disease, characterize changes in periodontal health, and determine the associations of age, race, gender, and tobacco use with periodontal status among US Navy personnel.* ***Methods:*** *Dental records from 1,107 personnel who entered military service in 1997 were gathered from eight US Navy dental treatment facilities. Demographic information, tobacco use status, and periodontal health status, as reflected by the Periodontal Screening and Recording (PSR) information recorded at each required dental examination during the 4-year observational period (1997 to 2001), were collected. To improve sensitivity in measuring the extent of periodontal disease, the standard five-point PSR scale was reexpressed as a "PSR grade."* ***Results:*** *Over 98 percent of Navy recruits exhibited some level of periodontal disease at initial examination. Most (76 percent) exhibited gingivitis of varying severity. Over a mean observational period of 3.4 years, 91 percent of subjects received at least one oral prophylaxis, and over 60 percent received two to four prophylaxes. Subjects with severe periodontal conditions received as many as 22 appointments for prophylaxis or periodontal therapy. From initial to final examination, periodontal status improved for 29.2 percent of subjects, deteriorated for 31.3 percent, and remained unchanged for 39.5 percent. Subjects presenting initially with healthy periodontia, or gingivitis without evidence of periodontitis, tended to deteriorate or remain unchanged, while those exhibiting periodontitis tended to improve with periodontal therapy. Race (non-White) and greater age at entry were significantly associated with increased risk for poorer periodontal health at both initial and final examination.* ***Conclusions:*** *Although a needs-based dental care model appears effective in managing periodontal disease among those receiving active therapy, patients who receive sporadic care may deteriorate over time. To maintain periodontal health in this population, appropriate preventive and periodontal therapies should be provided soon after entry and repeated at intervals specific to individual patient need.*

Key Words: periodontal disease, PSR, epidemiology, adults, risk assessment

Introduction

Periodontal diseases are a group of closely related conditions, of varying etiology, which manifest a variety of clinical presentations not only in adults but also in patients of all ages (1, 2). Gingival inflammation is quite prevalent among all age groups, affecting over 70 percent of children (3, 4), and nearly 100 percent of adults (4–6). Localized radiographic bone loss, periodontal attachment loss, and generalized periodontitis have been reported in children and adolescents (7–9). Although the prevalence of aggressive periodontitis among children and adolescents is rather low, ranging from less than 1 to 27 percent (7, 10, 11), both the prevalence and severity of periodontitis increase with age. In US epidemiologic surveys, over 43 percent of adults aged 35 to 44 years, and 74 percent of those aged 55 to 64 years, had at least one tooth exhibiting periodontal attachment loss of ≥3 mm; among these age groups, 12 and 35 percent, respectively, demonstrated attachment loss of ≥5 mm on at least one tooth (5, 12).

Few studies have evaluated periodontal health among military personnel. Results have varied, but, in general, mirror those of nonmilitary populations (13). In a study of 500 US Army personnel, Covington and colleagues (14) reported that 82 percent of subjects exhibited gingivitis, nearly 18 percent exhibited periodontitis, and only two subjects (0.4 percent) were disease-free. The prevalence of periodontitis increased with increasing age, affecting 7.7 percent of 18- to 24-year-olds, 15 percent of 25- to 34-year-olds, and over 40 percent of those aged 35 or older. In contrast, among 100 British military recruits, initially aged 16 to 20 years and evaluated over 30

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months, all subjects exhibited a lifetime cumulative attachment loss of ≥2 mm, and 40 percent exhibited attachment loss of ≥3 mm, at one or more intraoral sites (15).

The primary mission of the US Navy dental care delivery system is to maintain the oral health of all US Navy and Marine Corps personnel to ensure that each service member is fully prepared for deployment. Each member receives a comprehensive dental examination upon entry into military service. To the extent possible, all necessary dental treatment is completed during the recruit's basic training. Reexamination, as well as treatment of any newly identified dental needs, is required at least once annually. A required element of the dental examination is the documentation of periodontal health status using the Periodontal Screening and Recording (PSR) Index (16). According to the Navy's Oral Disease Risk Management guidelines, patients exhibiting PSR scores of 1 to 3 are managed with appropriate therapy provided by general dentists and dental hygienists; however, a PSR score of 4 in any sextant mandates a referral to a periodontist for further evaluation. The practitioner's assessment is recorded in the dental treatment record, and the patient receives appropriate education and treatment designed to manage the current condition and minimize the risk of future disease.

Although the US Navy endeavors to provide all treatment necessary to ensure periodontal health, operational requirements and the rigors of the military environment may preclude patients from receiving the continuity of care obtainable in a nonmilitary setting. As a result, periodontal health status may be compromised. Neither the prevalence of periodontal disease among Navy recruits, nor the long-term trends in periodontal health among this population, has been well studied. This knowledge is critical because the US military forces are comprised primarily of young and middle-aged adults, ages during which periodontal diseases tend to manifest and worsen. Therefore, the objectives of this study were to: a) assess the prevalence and severity of periodontal disease among Navy recruits; b) characterize changes in periodontal health status among these personnel during their first years of military service; and c) determine the relationships of age, race, gender, and tobacco use to the prevalence of periodontal disease in this population.

Methods and Materials

A random sample of eight US Navy dental treatment facilities (DTFs) located within the United States was selected. All enlisted personnel who entered the US Navy during the calendar year 1997, whose dental records were maintained at these DTFs, were eligible for inclusion in the study. For this retrospective analysis, the authors traveled to the selected DTFs during 2001 to digitize the subjects' dental records. Using laptop personal computers and flatbed scanners, the subjects' entire dental records, including health histories, radiographs, and all examination and treatment record entries, were archived as PDF files for subsequent review and analysis. To ensure subject anonymity, all subject identifiers were masked during the record digitization process.

The dental records of 1,107 subjects who commenced military service during 1997 were reviewed. Demographic data (gender, race, and age at entry into the Navy) and tobacco use status were determined from the recruit's in-processing and initial dental examination records. Trends in periodontal health over time were determined from the PSR information recorded at each required dental examination during the 4-year observational period (1997 to 2001).

This research protocol was reviewed and approved by the Institutional Review Board of the Naval Institute for Dental and Biomedical Research, Great Lakes, Illinois.

Data were analyzed to determine: a) the distribution of PSR scores at initial and final examinations for all subjects and b) differences in periodontal health related to age, gender, race, and tobacco use. Data analysis was accomplished using SAS version 8.02 statistical software (SAS Institute, Inc., Cary, NC). Alpha error level for all statistical analyses was set at $\alpha = 0.05$. Preliminary findings often guided additional data analysis. For clarity, detailed descriptions of these sub-sequent statistical analyses are included, where appropriate, in the Results section.

Results

The 1,107 subjects in this cohort had an average age at entry into the Navy of 20.17 (±2.52) years (range: 17.16 to 34.79 years). The majority were White (75 percent, based on the data available for 1,066 of the 1,107 subjects), male (85 percent), and did not use tobacco products at the time of entry into the Navy (69 percent, based on the data available for 956 subjects). All subjects received an initial PSR examination at in-processing, and one or more additional examinations at approximately annual intervals. The mean time from the first to the last PSR examination was 3.40 ± 0.47 years (range: 1.97 to 5.12 years).

To improve the PSR's sensitivity in measuring the extent of periodontal disease (in contrast to screening for severity), the standard five-point (0 to 4) scale, based on the patient's worst sextant score, was reexpressed as a PSR grade, as described in Table 1. Grade 1 (i.e., all PSR sextant scores = 0) represents a condition of optimal periodontal health; grades 2 and 3 correspond to gingivitis of increasing severity; grades 4 and 5 correspond to increasingly severe periodontitis.

Table 2 depicts the distribution of PSR scores and PSR grades observed at initial and final examination. At initial examination, the majority of subjects (52 percent) received a PSR score of 2; over 70 percent exhibited scores of 0, 1, or 2, while 28 percent had PSR scores of 3 or 4. The distri-

Table 1
Conversion of Worst-Sextant PSR Score into PSR Grade

Criterion	PSR grade
All PSR sextant scores = 0	1
At least one PSR score = 1 (or one PSR score = 2 and no score > 2)	2
At least two PSR scores = 2 (or one PSR score = 3 and no score = 4)	3
At least two PSR scores = 3 (or one PSR score = 4)	4
More than one PSR score = 4	5

PSR, Periodontal Screening and Recording.

Table 2
Distribution of Initial and Final PSR Scores and PSR Grades (*n* = 1,107)

	PSR score				
	0	1	2	3	4
Initial examination	18	198	575	280	36
	1.6%	17.9%	51.9%	25.3%	3.3%
Final examination	32	242	606	205	22
	2.9%	21.9%	54.7%	18.5%	2.0%
	PSR grade				
	1	2	3	4	5
Initial examination	18	482	343	247	17
	1.6%	43.5%	31.0%	22.3%	1.5%
Final examination	32	389	507	170	9
	2.9%	35.1%	45.8%	15.4%	0.8%

PSR, Periodontal Screening and Recording.

Table 3
Contingency Table of Initial PSR Grade by Final Observed PSR Grade (*n* = 1,107)

Initial PSR grade	Final PSR grade					
	1	2	3	4	5	Total
1	0	11	6	1	0	18
2	13	199	219	49	2	482
3	11	104	173	54	1	343
4	7	71	102	63	4	247
5	1	4	7	3	2	17
Total	32	389	507	170	9	1,107

PSR, Periodontal Screening and Recording.

bution of PSR scores at the final examination was similar, but with slightly more subjects (80 percent) receiving scores of 0, 1, and 2, and fewer (20 percent) receiving scores of 3 and 4. For both initial and final examinations, conversion to the PSR grade criteria resulted in less clustering of subjects in the middle category and a slightly greater proportion of subjects in the lower categories, yielding a more accurate representation of the extent of periodontal disease among this cohort.

Table 3 shows PSR grades for the initial examination versus the last examination available. Overall, 29 percent (323/1,107) of subjects demonstrated improvement in PSR grade, 31 percent (347) exhibited deterioration in PSR grade, and 39 percent (437) remained unchanged from initial to final examination. Among those subjects who exhibited changes in PSR grade, over 75 percent (69 percent of those who improved, 83 percent of those who deteriorated) changed by only one PSR grade category. Although the linear-by-linear association in this table is statistically significant ($P < 0.0001$), it is also clear that lower PSR grades tended to increase, while higher grades decreased, over time. To evaluate this effect, we conducted a repeated measures analysis of variance (ANOVA), with initial PSR grade as a "between-subjects" variable and time (initial PSR grade versus final PSR grade) as a "within-subjects" variable. Time was not a statistically significant factor ($P = 0.28$, means = 2.79 and 2.76 for initial and final PSR grade, respectively); however, there was a significant time-by-initial PSR grade interaction ($P < 0.0001$).

Table 4 shows the distribution of PSR grades at initial and final examination by race. The effect of race was significant at both examinations (Kruskal–Wallis test for singly ordered table; $P < 0.0001$ at initial examination and $P = 0.0053$ at final examination).

The Pearson correlation between age at entry into military service and PSR grade was 0.153 ($P < 0.0001$) at the initial examination and 0.08 ($P = 0.0075$) at the final examination.

Initial and final PSR grades were each subjected to ordinal logistic regression with the binary predictors of gender, race, and tobacco use and the continuous variable of age at entry into military service. For both initial and final PSR grades, only race and age were statistically significant (all $P < 0.004$). While the effects of tobacco use, as reported at initial examination, did not reach the significance criterion, tobacco use was moderately associated with higher PSR scores at both initial ($P = 0.369$) and final examinations ($P = 0.062$). Both non-White status and greater age at entry into military service were

Table 4
Initial and Final PSR Grades as a Function of Race (% of Subjects) (Kruskal–Wallis Test for Singly Ordered Table)

		PSR grade				
	n	1	2	3	4	5
Initial exam*						
White	799	2.0	48.2	29.9	19.0	0.9
Non-White	267	0.8	30.0	35.2	30.3	3.8
Final exam†						
White	799	2.4	36.8	47.8	12.6	0.4
Non-White	267	4.1	30.7	40.1	22.9	2.3

* $P < 0.0001$.
† $P = 0.0053$.

associated with higher PSR grades; however, there seems to be an attenuation of these effects over time.

Subjects with initial PSR grades of 5 had the greatest number of treatment visits for oral prophylaxis and periodontal therapy during the observation period. On average, each subject with an initial PSR grade of 1, 2, 3, or 4 had slightly less than one visit annually (range = 0.68 to 0.81 visits per year), while subjects with initial PSR grades of 5 had 1.93 visits per year (ANOVA; $P < 0.0001$). Over 91 percent of all subjects had at least one oral prophylaxis, and over 60 percent received two to four prophylaxes, during the observation period. All subjects with initial PSR grades of 5 had at least two prophylaxis or periodontal visits, with over 50 percent receiving between 5 and 22 visits.

Discussion

The success of periodontal therapy depends primarily on patient compliance with both home care and supportive, or maintenance, periodontal therapy (17, 18). Without regular professional intervention, patients may be incapable of maintaining oral hygiene at levels to prevent plaque accumulation and/or disease progression (19). However, because of the multifactorial nature of destructive periodontal diseases, in particular, even frequent regular oral prophylaxes may be insufficient to prevent deterioration in patients predisposed to periodontal disease (4, 20, 21). Therefore, to maximize therapeutic benefit and cost-effectiveness in a public health setting, it is critical to identify those at greatest risk for disease progression. In that regard, the current study suggests that the US Navy's focus on periodontal risk assessment and management is appropriate and at least somewhat effective, as over 72 percent of the subjects presenting with initial PSR grades of 4 or 5 exhibited improved scores at their final examinations (Table 3).

We noted a tendency for initially lower PSR grades to increase and higher grades to decrease over time (Table 3). While this convergence may be in part because of a regression-to-the-mean artifact, we believe it is driven to a large extent by allocation of resources to patients with the most severe conditions. In this regard, it is important to note that PSR grade is not an interval scale; nor is it a scale indexing the amount of clinical resources that would be required to move patients one unit from PSR grades of 5 to 4 or 4 to 3, versus grade 2 to 1. In addition, movement from grades 1 to 2 or 2 to 3 might reflect, in some cases, routine disease progression 1 year after prophylaxis. Although mean PSR grades did not differ between initial and final examinations, the 32 percent reduction in PSR grades of 4 or 5 (from 264 to 179 subjects; Table 3) probably represents a meaningful improvement in oral health.

In the current study, initial PSR grades represent periodontal status at the time of accession into military service. Anecdotal evidence suggests that many recruits seek dental care from their civilian providers during the weeks immediately preceding their enlistment. For these cases, the PSR grades recorded at military in-processing may reflect benefits from such recent treatment. In contrast, subsequent examinations are typically conducted at 1-year intervals, and PSR grades generally reflect oral conditions up to 1 year following the last treatment. For this reason, what may appear to be declines in periodontal health associated with the first years of military service might be rather because of an artifact of unequal treatment intervals for the baseline examination versus subsequent examinations.

Previous studies have reported strong correlations between periodontal disease and tobacco use (22, 23). Our study found a moderate, but statistically nonsignificant, association between tobacco use, as reported at entry into military service, and periodontal disease. Navy recruits are prohibited from using tobacco during their initial 8-week recruit training period. Although some personnel continue to abstain, the majority resume tobacco use immediately following this period, with nearly 90 percent resuming within 3 months (24, 25). It is possible that others, who did not use tobacco at the time of accession, begin tobacco use during their first years of military service (26). We have previously reported the prevalence of tobacco use among this cohort to be approximately 30 percent (27), which agrees reasonably well with other reports (28, 29). However, because our study was a retrospective review of dental treatment records, it was impossible, in most cases, to reliably determine tobacco use status at any time subsequent to the initial in-processing examination. Therefore, the nonsignificant association between tobacco use and periodontal disease found in the current study is not sufficiently compelling evidence to suggest the absence of a tobacco effect.

Noncompliance with oral hygiene instructions and supportive periodontal therapy is a primary factor in treatment failure and disease progression. Previous studies have noted that fewer than 50 percent of patients follow the maintenance programs recommended by their providers and that compliance diminishes further as the time following initial therapy increases (18, 30). Novaes and Novaes (18) reported that younger (less than 40 years) males receiving nonsurgical therapy were the least compliant with maintenance recommendations. In our study, the subject population consisted predominantly of male patients under the age of 30 years. Therefore, a lack of compliance and, hence, minimal improvement in periodontal health may be expected. However, we did note modest, and even substantial, improvements among many patients. This finding is noteworthy, considering the rigors of the military environment, which often limit the service member's availability for both professional and personal care.

It is important to note, also, that, although Navy personnel are required to receive at least one dental examination annually, an annual oral prophylaxis is not specifically required for all personnel. Only those exhibiting evidence of destructive periodontal disease (i.e., PSR scores of 3 or 4) are required to receive treatment. Patients exhibiting primarily gingival inflammation (PSR scores of 1 or 2) may receive oral prophylaxis on an elective basis as their duty schedules and DTF schedules permit. Often, DTF workloads and personnel duty schedules combine to limit availability for such treatment. Indeed, our data reflect that most Navy personnel receive oral prophylaxes at greater than 1-year intervals. Whether increased frequency of therapy would result in improved oral health among this population remains unanswered.

In summary, this study revealed that over 98 percent of young US Navy personnel exhibited at least some level of periodontal disease at initial examination upon accession into military service. Gingivitis, in varying severity, was found in the majority (76 percent) of documented cases, and these patients tended to deteriorate or remain unchanged over time. Patients who presented initially with periodontitis tended to improve with periodontal therapy. Most patients exhibited changes of only ±1 PSR grade category over the period of study. Race (non-White) and increased age at entry into military service were significantly associated with poorer periodontal health at both initial and final examination, while gender and tobacco use were not. However, the effects of race and age tended to diminish with increasing time spent in the US Navy dental care system.

Although a needs-based dental care model appears effective in managing periodontal disease among those receiving active therapy, and may be necessary to contain costs, patients who receive intermittent or sporadic care may deteriorate over time. To achieve and maintain periodontal health in these individuals, risk assessment is essential. Preventive dentistry services and periodontal therapy should be provided early in their military careers and repeated at intervals specific to the needs of each patient.

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