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DOES THE PRESENCE OF WATER FLUORIDATION ALTER THE USE OF DENTAL PREVENTIVE SERVICES ON UNITED STATES AIR FORCE BASES?

By

IRENE GENEVIEVE BOBER-MOKEN, BS, MS, DMD

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A plethora of preventive measures exists in the dental profession's armamentarium to minimize the incidence of dental caries. Although water fluoridation has been the most effective community measure available over the past fifty years, other individual methods include the use of pit and fissure sealants, topical application of fluorides, oral hygiene counseling, diet planning and dental prophylaxis. Are these procedures employed at different rates relative to the presence or absence of fluoride in the community water supply? This study was undertaken to answer this question in the United States Air Force. Utilization rates for seven preventive procedures, namely application of pit and fissure sealants, topical fluoride application, diet planning, fluoride carriers/mouth protectors, oral hygiene instructions, oral hygiene/soft tissue indices, and adult prophylaxis were calculated during 1995- 1997 for 20 selected Air Force installations. Annual mean utilization rates were compared between two sets of ten installations, paired for geographic location, population

size and major command but differed in water fluoridation. The difference observed between the rates ranged between -0.007 and 0.0438 was not statistically significant at an $\alpha \leq 0.05$ level of significance.

DOES THE PRESENCE OF WATER FLUORIDATION ALTER THE USE OF DENTAL PREVENTIVE SERVICES ON UNITED STATES AIR FORCE BASES?

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INTRODUCTION

Community water fluoridation has been the quintessential preventive intervention for dental caries in the United States for over five decades accounting for a decreased prevalence of dental caries of between 30 and 60 percent (Ripa 1993). Water fluoridation, however, is not the sole preventive measure against dental caries. Other preventive methodologies are used alone or in conjunction with water fluoridation. These include the following: pit and fissure sealants; fluoride supplements; topical fluoride via professional application or personal use of fluoridated tooth pastes, mouth rinses, and gels; dietary counseling and modification, and oral hygiene instruction.

Despite all the preventive efforts, dental caries still persist as a common infectious disease which affects over 45 percent of the United States military active duty population and 79 percent of recruits entering into military service. The average active duty serviceman requires 2.75 restorations and new recruits 4.4 (York, Pointdexter, and Chisick 1995a, 1995b). In 1978, the Department of Defense (DOD) issued a Safe Drinking Water Directive (DODD 6230.1) recommending military installations adjust the fluoride content of DOD public water systems (Warrick 1996). Currently, 72.4% of the United States Air Force's (USAF) installations provide fluoridated water to 81.7% of its active duty population (Fancher 1997; Air Force Association 1997). USAF airmen have a mobile life style; reassignments occur every three to five years. Deployments to remote corners of the world are increasingly common, potentially affecting dietary habits and creating a stressful environment conducive to oral hygiene demotivation (Newbrun 1989). They also participate

in a unique dental care system; namely, one of universal access with mandated annual examination and treatment. Does this unique environment place USAF airmen at a different risk for dental disease? Do USAF dentists alter their utilization of preventive measures when assigned to a facility without fluoridated water or fluoridated at suboptimal levels? It is the intent of this thesis to determine if a difference in the use of select dental preventive procedures exist between USAF bases that provide fluoridated water at optimal levels versus those at suboptimal levels.

REVIEW OF LITERATURE

Etiology of Dental Caries. Dental caries is one of the most common infectious diseases afflicting mankind since Paleolithic times (Ring 1985). Its causation was attributed to a "tooth worm" and other presumed causes from ancient Babylon through the 19th century when microorganisms were found in carious lesions and Miller proposed his "chemoparasitic" or "bacterial acidogenic theory" (Lufkin 1948). According to Miller, these microorganisms create acids that cause an initial decalcification allowing the bacteria to invade the tooth (Shafer, Hine, and Levy 1974). Loesche's "specific plaque hypothesis" proposed that there were specific bacterial plaques that were responsible for caries and periodontal disease. Marsh modified these concepts with his "ecological plaque hypothesis" in which some factor triggers a shift in the proportions of the resident microflora to make it cariogenic (Krasse 95; Kidd and Joyston-Bechal 1997). Miller had isolated 22 different types of oral microorganisms; by 1915 most attention was concentrated on *Lactobacillus acidophilis*. However, by

the 1940's extensive studies had demonstrated that aciduric streptococci and staphylococci could be found in sufficient numbers to suggest a role equal to that of lactobacilli. Currently, the primary bacteria involved include *Streptococcus mutans* and *sobrinus, Lactobacilli casei* and *Actinomyces naesundii* and *A. viscosus (*Mundorff-Shrestha et al 1994; Newbrun 1989).

Microorganisms, however, are not the sole arbiter of dental caries. Recognized as a multifactorial disease, the following host factors play a role: saliva, tooth morphology, dietary sugar and starch, oral hygiene and exposure to fluorides (Newbrun 1989; Krasse 1984). Saliva acts as a natural defense mechanism by its ability to promote remineralization (i.e., the deposition of mineral in demineralized enamel) thus forming a less soluble enamel by the remodeling of enamel (Beltran and Burt 1988). Sugar's relationship to caries was recognized by Miller and confirmed with epidemiological studies in the 1930's, World War II, and studies of populations adopting Western dietary patterns over a short period of time (Burt et al 1988; Newbrun 1989). An axiom that a clean tooth cannot decay had pervaded the dental mindset as indicated by Andlaw's review in 1978. This idea has been challenged by Hunter (1988) who reported no consistent relationship between oral hygiene and dental caries; Kidd's and Joyston-Bechal's (1997) statement that oral hygiene alone without fluoride, and sugar and starch moderation may not be enough to prevent dental caries. The cariogenicity of plaque is more dependent on external factors such as the amount and frequency of sucrose intake, the buffering capacity and volume of saliva (Kidd and Joyston-Bechal 1997).

Fluoride and Dental Caries. Fluoride's effect on changing the enamel of teeth was first observed in 1874 with Ernhardt's studies in dogs exposed to fluoridated food. Albert Denninger, in his paper to the Rhine Society of Natural Sciences, lauded fluoride as "an agent

against diseases of the teeth" and in 1902, a Danish pharmaceutical company marketed a fluoride substance to "strengthen" teeth. Carl Roe in 1894, at the Center for Dental Hygiene in Dresden, observed an increased resistance to caries in children who were exposed to water rich in lime (Ring 1985). In 1916, McKay and Black collaborated in research on "Colorado Brown Stain" (fluorosis) and Dean established an inverse relationship between fluoride concentration in the communal water supply and the prevalence of dental caries (Shafer, Hine and Levy 1974).

Bibby (1944) reviewed the experimental literature regarding fluoride between 1933 and 1944. He reported that children had a 90-95% decrease in caries in the anterior teeth and about a 25% decrease in molars. Experimental caries in rats led to the belief that fluoride acted preeruptively to decrease caries (Cox et al 1939). This structural theory of resistance (i.e., fluoride being incorporated into the hydroxyapatite making it caries resistant) vied with the oral environmental theories that proposed that fluoride acted posteruptively "arresting caries" or preventing its initiation (Biddy 1944; Cox et 1940; Riodan 1993). Despite which theory was propounded, the clinical trials agreed that this caries reduction primarily involved smooth surface caries and to a lesser degree pit and fissure caries (Cox et al 1939). The ideal water fluoride concentration to obtain the maximum beneficial caries reduction with minimal fluorosis, especially of moderate grade, was determined to be 1 part per million (ppm) (Ast 1956). Constant intake of low-concentration fluoride is currently seen as promoting a more rapid and effective remineralization by enchancing crystal growth. Additionally, if present when the tooth is being challenged by acids, the fluoride diffuses with the acid and inhibits dissolution of the crystal (Beltran and Burt 1988).

An early experimental clinical study on artificially fluoridated water was carried out in Kingston and Newburgh, New York. Beginning in 1945, a 56% decrease in Decayed, Missing, Filled (DMF) tooth index was observed after 10 years (Ast 1956). The Grand Rapids (artificially fluoridated), Muskegon (control city), and Aurora (natural fluoride level at 1.2ppm) study demonstrated that artificially fluoridated water gave the same beneficial effect as water naturally containing fluoride (Ast 1956). Communities saw the benefit of water fluoridation from these early clinical trials and thus began nation-wide efforts to fluoridate local water supplies. In the United States, water fluoridation has contributed to the increase in caries free children, from 28% in 1970 to 49.9% in 1986 (White, Antczak-Bouckoms, and Weinstein 1989).

Water fluoridation is not the only effective manner in which fluoride is made available to the oral environment. Topical application via toothpaste has been available since the late 1950's when stannous fluoride was incorporated into Crest (trademark of Procter and Gamble). Modifications were made in the formulation of toothpaste with the introduction of monofluorophosphate in the 1960's and sodium fluoride in the 1970's (Krasse 1995). Ninety-five percent of toothpastes on the market today are fluoridated. Professional application of higher concentrations of fluoride pastes of 2% sodium fluoride, 1.23% acidulated phosphate fluoride (APF) or 8% stannous fluoride has realized between a 28-32% caries reduction (Newbrun 1992). The efficacy of fluoride in preventing caries is related to its bioavailability when enamel demineralization is occurring. Frequency of fluoride ingestion is more important than its concentration. A level of 0.04-0.1 ppm of fluoride in plaque fluid prevents the enamel demineralization and promotes remineralization following a

cariogenic challenge (O'Mullane 1995). Therefore, increasing the availability of fluoride slows the development and progression of carious lesions, oftentimes enabling a reversal of the lesion (Brown and Selwitz 1995).

Pit and Fissure Sealants. Fluoride is currently credited with decreasing the prevalence of dental caries by 60% (combination of both water fluoridation and fluoridated tooth pastes) (Ripa 1993). However, this effect has been most predominant on the smooth surfaces of the tooth (i.e., interproximal surfaces) with a lesser effect on the pit and fissure surfaces (i.e., occlusal surfaces). Pits and fissures, once thought to be defects of nature, develop normally in a tooth during its morphogenesis. Their narrow width and uneven depth may trap food and bacteria leaving them susceptible to decay.

Occlusal surfaces of the teeth comprise 19% of the surfaces at risk for 12-14 years old children, yet account for 88% of the caries in these individuals (Waggoner and Siegal 1996). Susceptibility to occlusal caries, however, is not limited to childhood. Seventy-seven percent of caries activity on posterior teeth of 17-22 years-old college students involved pit and fissures, with a 9.9% incidence rate for occlusal caries occurring 11-14 years post eruption in the first molars and a 14% incidence rate for 5-8 years post eruption for second molars (Manton and Messer 1995).

Attempts to minimize the occlusal surface's susceptibility to caries included G. V. Black's "extension for prevention" in 1900; Hyatt's prophylactic odontotomy in 1923; and fissure obliteration or impregnation with silver nitrate in 1942, with zinc oxide in 1950, and black copper cement in 1951 (Ryge and Mertz-Fairhurst 1987). In 1955, a breakthrough came with Buonocore's acid-etch technique and in 1967, Cueto and Buonocore reported an

86.5% decrease in pit and fissure caries after one year when sealed with an adhesive (Cueto and Buonocore 1967). Clinical trials found these early cyanoacrylates unsuited for long-term use in the mouth; Bowen's BIS-GMA (bisphenolA and glycidyl methacrylate) system improved clinical performance. Sealants' ability to inhibit caries was originally tested by having the carious teeth sealed on one side of the mouth and contralateral teeth serving as controls. But, once the effectiveness of sealants was demonstrated, it was no longer ethical to test effectiveness this way and after 1976, sealant effectiveness has been measured with respect to sealant retention (Ripa 1993b). In 1981, 70% of sealants were still intact after four years and in 1993, 50% of sealants were still retained after 5-7 years (Ryge and Mertz-Fairhurst 1987; Ripa 1993b). It has been estimated that occlusal caries have been avoided for 71% of children with the use of sealants (Rozier 1995). The benefit from sealants is not only limited to virgin teeth. When incipient caries were sealed the decay produced after five years was 10.8% versus 51.8% of non-sealed teeth with incipient pit and fissure caries. The odds ratio of this difference is 8.88 (Heller et al 1995).

Utilization of sealants by dentists slowly increased as the technology improved. In the United States, 38% of the dentists were using sealants in 1975; this number increased to 78% in 1992 (Manton and Messer 1995). Medicaid coverage for sealants began in the mid-1980's (Rozier 1995). However, the NHANES III Phase I (1988-1991) data has revealed that only 15% of permanent first molars were sealed in children 5-11 years of age and 11% in the 12-17 years old; fewer than 10% of second permanent molars were sealed in the 12-17 year olds (Selwitz et al 1996). The need for sealants in recruits entering the USAF has been estimated at 37% (Chisick 1998). The predisposition to use pit and fissure sealants is

dependent on the dentists having been exposed to their use in dental school or advanced training (Siegal 1995; Chisick 1998).

Air Force Installations. The Air Force's active duty population is stationed worldwide in 87 major and 86 minor installations; 74 of the major and 82 of the minor installations are in the continental United States (CONUS) and 17 are in foreign countries (Air Force Association 1997). An integral part of the local community, the bases receive their utilities from the surrounding community. Water fluoridation, despite its 50-year history, remains controversial. Not all communities fluoridate their water and some do not fluoridate to levels recommended by the leading authorities (Reeves 1995a).

Optimal fluoride levels are determined in relation to the average of maximum daily air temperatures over at least a five-year time period and usually range between 0.6-1.2ppm fluoride (Reeves 1995b). A 1996 survey, conducted by the USAF Dental Corps, revealed that 72.4% of the major AF bases were providing fluoridated water within the recommended limits, reaching 81.7% of its active duty population. Nineteen bases were using nonfluoridated or suboptimally fluoridated water; nine bases were located in CONUS and 10 overseas (Fancher 1997).

The USAF maintains a dental clinic at all major installations, with manning roughly equivalent to one dental officer per 350 active duty personnel assigned. General dentists comprise 75% of the dental corps worldwide with the specialists assigned primarily at training facilities or overseas (OS). The mission of the dental corps is to keep the active duty population dentally fit to deploy at a moment's notice. Once deployed, minimal, if any, dental care may be available for extended periods (Foreman 1994). Airmen, upon routine

reassignment to an OS base, are examined prior to leaving CONUS to mitigate the risk of dental emergencies.

Air Force Demographics. The USAF is an all-volunteer force that reflects the multi-ethnic composition of the United States. Downsizing since 1987, its composition has remained fairly constant. See Table 1 for its race, gender, educational level and rank structure breakdown. The gender and race/ethnic make-up impacts on the distribution of dental disease, as does an individual's rank and education. The USAF is a young service; its enlisted members average 28 years old and its officer corps average 36 years old (Taylor 1997a, 1997b). This age group was shown by York (1993) to be caries prone with 67.6% of restorations being placed in 18-34 year olds due to primary caries.

The most recent detailed prevalence data for the oral health status of active duty servicemen, stratified by age, gender and race/ethnic categories was the Tri-Service Comprehensive Oral Health Survey (TSCOHS) published in June1995 (York, Pointdexter and Chisick 1995a). Service-specific break out of Air Force members' data has yet to be released. However, restorations required are comparable with Meyer's 1993 study of Navy Personnel. So the TSCOHS values are probably fairly representative of the actual oral health status of USAF airmen.

TSCHOS revealed that 45.5% of the servicemen currently on active duty needed restorative care. Of those requiring restorations (fillings), the average servicemen needed 2.8 restorations with 8.1% requiring more than seven fillings (York , Pointdexter and Chisick 1995a). These numbers are substantially lower than those seen for recruits coming into the

Table 1.Educational level, gender, and race/ethnicity demographics for the USAF active duty population between 1995-1997. (Source:"Air Force Almanc" published in May of the respective years by the Air Force Association)

Year	1997			1996			1995		
Total USAF/AD Population	384996			396382			422320		
	Percent of Officers	Number	Percent of AF pop.	Percent of Officers*	Number	Percent of AF pop.	Percent of Officers*	Number	Percent of AF pop.
OFFICERS	100.00%	76388	19.80%	100.00%	78444	19.80%	100.00%	81003	19.20%
Black	5.80%	4440	1.15%	5.70%	4448	1.10%	5.70%	4629	1.10%
Women	15.80%	12047	3.13%	15.40%	12068	3.10%	15.20%	12322	2.90%
Other Minorities	4.00%	3069	0.80%	3.70%	2929	0.70%	3.50%	2821	0.70%
Unknown	1.64%	1251	0.30%	0.20%	137	<0.05%	0.10%	111	0.03%
Baccalaureate degree	43.80%	33455	8.70%	38.80%	30423	7.70%	38.60%	31285	7.40%
Master's degree	45.03%	34401	8.90%	39.30%	30824	7.80%	39.60%	32063	7.60%
Doctoral/Professional degree	9.53%	7281	1.90%	1.10%	891	0.20%	1.40%	1148	0.30%
	Percent of Enlisted	Number	Percent of AF pop.	Percent of Enlisted	Number	Percent of AF pop.	Percent of Enlisted	Number	Percent of AF pop.
ENLISTED	100.00%	308608	80.20%	100.00%	317938	80.20%	100.00%	341317	80.80%
Black	18.60%	57396	14.90%	17.00%	53986	13.60%	16.70%	57018	13.50%
Women	20.80%	64176	16.70%	16.20%	51478	13.00%	16.60%	53433	12.70%
Other Minorities	6.70%	20774	5.40%	5.10%	16226	4.10%	4.60%	15701	3.80%
Below High school	0.01%	41	0.01%	0.01%	32	0.01%	0.01%	32	0.01%
High school	23.13%	71373	18.54%	20.29%	64515	16.28%	21.70%	74019	17.50%
Some college	59.13%	182467	47.39%	62.74%	199471	50.32%	61.97%	211518	50.05%
AA/AS degree	12.92%	39864	10.35%	12.38%	39362	9.93%	11.90%	40548	9.60%
Baccalaureate degree	4.27%	13174	3.42%	4.03%	12827	3.24%	3.91%	13337	3.20%
Above Master's degree	0.55%	1689	0.44%	0.54%	1731	0.44%	0.51%	1863	0.44%

* Education levels given for only the 'line officers',therefore percentages do not add up to 100% of the overall officer totals.

services from the general population. Seventy-nine and three-tenths percent of the new recruits need an average of 3.56 restorations with 23.3% needing more than seven. Those individuals with the highest percentage of decay were young (17-24 years old), male, non-white and belonging to the enlisted ranks (York, Pointdexter and Chisick 1995a, 1995b). It becomes apparent that a combination of preventive and restorative procedures are needed to ensure a dentally-fit fighting force.

USAF Clinical Dental Preventive Methodologies. All active duty airmen receive an annual dental examination. A medical history is taken and evaluated for its impact on oral health and/or patient management. Full mouth probing is performed to assess the patient's periodontal status. Both a clinical and radiographic evaluation for caries and other oral pathology is performed. Radiolucent lesions on proximal surfaces, noted on the bite-wing radiographs, are carefully assessed. Lesions extending to the dentin-enamel junction, but not crossing into the dentin are not routinely condemned to restorative procedures. Their re-mineralization or continued disease progression will be monitored at subsequent annual examinations. This practice is consistent with the ability of the enamel to remineralize (Anusavice 1995).

Clinical findings dictate treatment regimens. Most airmen receive an annual dental prophylaxis (i.e., cleaning) and tooth polishing using a fluoride containing prophylaxis paste. The need for topical fluoride applications is dependent upon dental caries activity or susceptibility. Guidelines detailing appropriate topical fluoride regimens exist; however, they serve only as recommendations. No regulations mandate their use and interpretation of them rests with the examining dental officer. In most cases, an airmen with incipient, recurrent, or

root caries will receive at least one office topical fluoride treatment (i.e., a four-minute application of 1.23% APF in a tray). Airmen with active (caries present in the past three years but less than three smooth surface lesions per year) or rampant caries (three or more smooth surface lesions per year) will receive multiple office topical fluoride treatments, often delivered during the restorative appointments.

Sealants are applied whenever warranted by the examining dentist. A heightened awareness of the role of sealants in the AD population followed the publication of Foreman's (an USAF pediatric dentist) findings. Only 13.3% of the active duty airmen had sealants, while 47.5% had at least one second molar, which met Ripa's diagnostic criteria for benefiting from sealants (Foreman 1994).

Oral hygiene instructions (OHI) are provided at the prophylaxis appointment and all subsequent appointments when warranted. These instructions invariably review brushing, flossing and use of other hygiene instruments tailored to the individual's requirements (e.g., presence of braces, fixed or removable partial dentures, and implants). Soderholm (1995) stressed the importance of oral health education as a cost-effective approach to decrease dental disease, as it impacts both dental caries and periodontal disease over the lifetime of the patient.

Dietary assessment and diet modification play an important role in preventing dental caries, since the frequency of carbohydrate ingestion alters the rate of caries progression (Brown and Selwitz 1995). No official guidelines exist in this arena; diet planning and modification are tailored to the individual patient and given at the dentist's discretion.

Research Question. Preventive procedures presently constitute 40.4% of the USAF dental corps' clinical services. This indicates a paradigm shift to an increasingly prevention-oriented practice that reflects the philosophy of the USAF's Surgeon General's Office. But are these preventative practices evenly distributed through out the Air Force? It is the intent of this study, therefore, to determine if the use of select preventive procedures differ between USAF bases that are supplied with optimally fluoridated water and those that have either non-fluoridated or suboptimally fluoridated water.

MATERIALS AND METHODS

Twenty bases were selected to evaluate the utilization of dental preventive measures; ten suboptimally water fluoridated bases were compared with ten optimally fluoridated bases. Base selection was not random but a convenience sampling to facilitate pairing. Bases were paired with respect to geographic location, size of the Air Force active duty (AD) population, and the major command to which the base was assigned. Table 2 lists the selected bases, their population size by year, major command, and water fluoride level. Pairing in this manner was an attempt to serve as 'pseudo-controls' for variables that could not be controlled for on an individual base basis, but may impact either dental disease prevention or treatment. These variables included age, gender, race/ethnicity, education, access to care, and treatment methodologies of the dental practitioners. Major commands and specific missions dictate personnel deployment that would affect an individual receiving dental care at their assigned

Table 2. Selected USAF bases by geographic location, active duty population, major command, and fluoride level.

Base Pair	Location	Fluoride Level	Active Duty Population 1995	1996	1997	Major Command
1	CONUS	OPT	7115	7213	6409	Air Mobility Command
1	CONUS	SUB	4992	5146	5146	Air Mobility Command
2	CONUS	OPT	2161	2149	2537	AF Materials Command
2	CONUS	SUB	2104	2098	2098	AF Materials Command
3	CONUS	OPT	4350	4350	3506	AF Space Command
3	CONUS	SUB	4189	4299	4194	AF Space Command
4	CONUS	OPT	3591	3655	3655	AF Space Command
4	CONUS	SUB	3255	3255	3255	AF Space Command
5	CONUS	OPT	1415	1541	1292	Air Education & Training Command
5*	CONUS	SUB	1993	2402	2121	Air Education & Training Command
6	OS	OPT	6772	6565	6565	Pacific Air Forces
6	OS	SUB	7300	7300	7228	Pacific Air Forces
7	OS	OPT	2764	2741	2725	Pacific Air Forces
7	OS	SUB	2761	2270	2548	Pacific Air Forces
8	OS	OPT	2094	2473	2766	US Air Forces in Europe
8	OS	SUB	3000	3163	3367	US Air Forces in Europe
9	OS	OPT	4509	4135	3899	Pacific Air Forces
9	OS	SUB	5538	5538	5538	Pacific Air Forces

*Listed AD population in the "Air Force Almanac" did not include its 4000 cadets who were included in clinic procedure totals. Therefore the rates were calculated with the corrected total populations.

home station. Likewise, overseas locations provide care to both the active duty personnel and their family members and are manned with more dental specialists than are the CONUS facilities. An assumption was made, namely, that similar racial, age and gender composition existed between the paired base populations.

Dental Service Reports (DSR) covering fiscal years 1995, 1996, and 1997 that enumerated the clinical procedures rendered at the specific USAF dental clinics were supplied by the Dental Directorate in the Office of the Surgeon General at USAF

Headquarters, Washington, D.C. The following dental preventive procedures were evaluated: adult prophylaxis, topical fluoride application, pit and fissure sealants, plaque and tissue indices, individual oral health counseling (OHI), dietary planning, and mouth protectors/fluoride carriers. See Table 3 for a description of each of these preventive services as used in the USAF Dental Corps.

Annual utilization rates (number of a given procedure at one base in a specific FY divided by that base's population in the same FY) were calculated for each of the clinical procedures both on an individual year basis and as an aggregate. Only nine base pairs could be analyzed; one overseas pair had to be eliminated since the DSR data was not reported separately for the two facilities but were totaled together.

The three annual utilization rates per procedure from each of the optimally fluoridated bases were totaled together creating a sample size of 27. The same was done for the suboptimally fluoridated bases. The difference between the rates was found by subtracting the rates of the optimally fluoridated base from the rates of its paired suboptimally fluoridated base. A positive utilization rate difference would indicate that more of the preventive procedures were being rendered at those facilities that did not have the beneficial effects of fluoridated water. A negative utilization rate difference indicated that more of the preventive clinical procedures were being accomplished at bases that were optimally fluoridated. Utilization rates were also calculated for the Air Force population overall for each procedure.

The two-tailed t-test was used to evaluate the procedures' rate difference when they followed a normal distribution. However, if data was not normally distributed, as determined

Table 3. Selected preventive clinical services as defined and counted by the USAF Dental Corps.

Adult Prophylaxis

Removal of exogenous stain, plaque and supragingival calculus by polishing and/or instrumentation on permanent dentition. Credit one per appointment.

Topical Fluoride Application

Topical application of fluoride substances to the entire dentition of an individual by a dental officer, hygienist, or dental technician. Not to include fluoridated prophylaxis pastes. Credit one per patient treated.

Dietary Planning

Specifically designed sessions for individual dietary/nutritional oral history taking and diet planning. Credit one per appointment.

Individual Oral Health Counseling

Thorough personal counseling and/or demonstration to individual patient of procedures to attain and maintain oral health. Credit one per counseling session.

Application of Pit and Fissure Sealants

The use of acid etch resin technique as a primary preventive procedure. Enamel etching is included in the Cumulative Time Value count for this procedure. Credit one per tooth treated.

Plaque and Tissue Indices.

Clinical indices and tests used to identify bacterial plaque accumulation and/or determine soft tissue health response (e.g., plaque, debris, and periodontal indices; bleeding points and phase contrast microscopy). The name of the index or test and its numerical or descriptive value must be recorded in the patient's record
Credit one per index or test recorded.

Mouth protector and/or fluoride carriers.

A device constructed of acrylic resin or vinyl-like material to protect the hard and soft tissues of the mouth or for applying topical fluoride. Credit one per device.

by the Kolmogorov-Smirov Normality Test, the Mann-Whitney Test was performed. A p-value of 0.05 was used as the level of statistical significance. Statistical analyses were conducted using the Minitab System.

A summation of annual procedure rates for each base was performed to provide an overall procedure mean in its respective sample, namely suboptimal or optimal fluoridation, that was than compared against the world-wide USAF mean. The percentage change of annual utilization rates was calculated by subtracting the rates for 1995 from those in 1997 and dividing by the 1995 rate to provide an assessment of the change in preventive practice. Lastly, a ratio of preventive procedures to restorative procedures was determined by dividing the percentage of overall clinic productivity derived from preventive procedures by the percentage from restorative (e.g., amalgams and tooth-colored fillings) procedures.

RESULTS

The utilization rates of topical fluoride application, pit and fissure sealants, oral hygiene instructions, oral hygiene and soft tissue indices, adult prophylaxis, diet planning, and fluoride carriers/mouth protectors showed very low mean differences, ranging from -0.007 to 0.0438 per person. None of the rate differences between the paired optimally and suboptimally fluoridated bases in the aggregate sample (N=27) were statistically significant at an $\alpha < 0.05$ level. Table 4 lists the descriptive statistics for the seven preventive procedures. Except for the use of fluoride carriers/mouth protectors, all the mean differences were nega-

tive indicating that the optimally fluoridated bases were providing more preventive services to its active duty personnel than were those facilities without fluoride or at suboptimal fluoride levels.

Table 4. Statistical results for the utilization rate differences of preventive procedures between bases with and without optimally fluoridated water.

Procedure	Distribution of Data	Mean Rate Difference	Standard Deviation	p-value	95%CI Lower	95%CI Upper
Topical Fluoride Treatment	Normal	-0.156	0.443	0.06	-0.330	0.019
Adult Prophylaxis	Not normal	-0.155	0.475	0.08	-2.155	0.016
Fluoride Carriers	Not normal	0.0438	0.1179	0.11	-0.0006	0.0444
Hygiene/Tissue Indices	Normal	-1.29	4.18	0.08	-2.951	0.353
Diet Planning	Not normal	-0.0007	0.189	0.7	-0.00106	0.00037
Sealants	Normal	-0.06	0.34	0.36	-0.1922	0.0719
Oral Hygiene Instructions	Not normal	-0.358	1.06	0.14	-0.6073	0.1256

Appendix 1 contains the utilization rate calculation data and descriptive statistics for each of the individual preventive procedures. Appendix 2 presents a comparison of the sample size, mean, standard deviation, confidence interval, and p-values for both the the aggregated data and the individual years' data. In the latter, one p-value was found to be

significant at 0.0469, occurring for diet planning in FY 96. During FY 96, base OPT 6 accomplished 30% more diet plans than during the previous year when it had been already out performing other OPT bases by a factor of three to ten. This one base was out of line from the other bases skewing the data for this procedure.

The suboptimal and optimal bases in our sample had rate ratios ranging from 0.15 to 7.00. Excluding diet planning and fluoride carriers/ mouth protectors (where the Pacific Air Force bases OPT 6, OPT 7, and SUB 9 had such extreme values) the ratio range narrowed to 1.16-1.46 (see Table 5). If viewed as a concept similar to risk ratio, these values were not significant.

Table 5. Mean utilization rates (per person) for preventive procedures from 1995-1997 for suboptimally (SUB) and optimally (OPT) fluoridated bases compared to world-wide USAF rates.

Preventive Procedure	Rates			Rate Ratios		
	USAF Overall	SUB	OPT	SUB/ USAF	OPT/ USAF	SUB/ OPT
Topical Fluoride	0.6240	0.9120	0.7250	1.4615	1.1619	1.2579
Sealants	0.2390	0.3380	0.2770	1.4142	1.1590	1.2202
OHI	2.8310	3.3500	3.8200	1.1833	1.3493	0.8770
Indices	9.2290	11.2500	11.5200	1.2190	1.2482	0.9766
Prophylaxis	1.0020	1.2400	1.2800	1.2375	1.2774	0.9688
Carriers	0.0230	0.0240	0.1610	1.0435	7.0000	0.1491
Diet Plans	0.0097	0.0350	0.0050	3.6082	0.5155	7.0000

The percentage rate change that occurred from 1995 to 1997 for each of these procedures when comparing bases for their fluoridation level is given in Table 6. Overall AF percentage changes are also listed. The Air Force, worldwide ex-

perienceed an increase in all dental preventive procedures; ranging from 0.90% for adult prophylaxis to 33.70% in sealants.

The greatest increase, as well as the only procedure where suboptimally fluoridated bases exceeded those optimally fluoridated, was for the use of

Table 6. Percentage difference in the utilization rates of preventive measures from 1995 to 1997 between bases which were optimally (OPT) fluoridated and those that were not (SUB).

	OHI	Sealants	Fluoride Treatment	Adult Prophy	Diet Plans	Hygiene Indices	Fluoride Carriers
SUB % Difference	-15.99	64.3	26.2	-2.52	-10.57	30.27	7.15
OPT % Difference	-3.81	55.95	38.37	-4.16	47.17	43.35	38.68
USAF Overall % Diff	8.11	33.7	22.66	0.9	18.8	31.88	20.29
Ratio SUB/OPT	4.2	1.15	0.68	0.61	-0.22	0.7	0.18

sealants with 64.30% and 55.95% respectively. In all other procedures, excepting OHI, the optimal bases realized a larger percentage change in this three-year interval as compared to the suboptimal bases. Oral hygiene instructions and adult prophylaxis saw a decrease in annual rates for the sample base pairs.

While the Air Force worldwide increased its use of preventive procedures by 11.2% between 1995 and 1997, its restorative procedures decreased 16.2%. Comparing the sub and optimally fluoridated bases with respect to their preventive and restorative procedures the following was found: suboptimally fluoridated bases had a overall means for preventive

versus restorative procedures of 41.09% and 7.07% (ratio of 6.08) while the optimally fluoridated bases had an overall means of 42.4% and 6.44% (ratio of 7.12) respectively.

DISCUSSION

The annual individual utilization rates of dental preventive procedures in the USAF increased between 1995 and 1997. However, this historical retrospective study was unable to discern any statistically significant difference in the mean utilization rates of topical fluoride application, pit and fissure sealants, oral hygiene instruction, soft tissue/oral hygiene indices, diet planning, adult prophylaxis and fluoride carriers/mouth protectors between bases which were supplied with optimally fluoridated water and those that were not. Although 50% of the non-fluoridated bases were sampled, the sample size was small (N=27) diminishing the power of the study. Many other variables could have facilitated the resultant non-significant outcome.

Base populations, both in terms of patients requiring care and dental staffing available to treat them, are not static. For dental officers, the usual time on station is three years. Two of the overseas bases (in different major commands) are considered remote assignments with tour lengths between 12-18 months. Likewise, base personnel are rotating more quickly with more frequent deployments. The demographic variability, especially in the distribution of the high caries personnel, namely the young (17-24 years old) non-white males would impact

clinical procedures. The assumption that the bases would have a relative random mix of personnel may not have been valid.

The mere fact that the base is capable of supplying fluoridated water does not necessarily translate into the active duty population being exposed to it. Consumption of fluoridated water could be affected by numerous factors including the following: personal preference to drink only bottled water, hours spent on base during which one could consume the base's water, the amount of water actually consumed, and whether one resided on base or in the community which may not be fluoridated. Other sources of fluoride to personnel through toothpastes and mouthrinses would greatly impact an individual's dental condition which would translate into what clinical procedures would need to be rendered. To truly see the impact being assigned to a water fluoridated location one would need to look at individual patient records to compare the treatment received compared to assignment history. One could conceivably obtain base water fluoridation histories. Unfortunately, existing dental records do not annotate information regarding other exposures to fluoride, that is use of fluoridated tooth paste and mouth rinses and if the patient is actually drinking fluoridated water, that would influence the findings.

The education and training of the assigned dentists could also impact on how they use the assorted preventive methodologies. General dentists comprise 75% of the dental corps, but there are three different 'grades' of general dentists: without any advanced trained, a one-year residency and a two-year residency. This mix of training, coupled with the time frame of when each had been accomplished would clearly alter an individual and subsequently the base's practice. Although an attempt was made to pair bases with known billets for

pedodontists (who historically have a higher use of preventive methods and would likely run the clinic's preventive program), no attempt had been made to see if these billets were actually manned. The assignments to remote bases tend to be given younger dentists, with or without advanced training. These factors could have had an impact on base pairs 6, 7 and 8.

The aggressiveness of a clinic's preventive dentistry program will also impact on that clinic's overall preventive totals. With a range of 29.9% to 48.3% of total clinic procedures being preventive in nature, certain bases seem more focused on prevention. Was this reflective more of patients' needs or the dentists' philosophy?

The dental corps exists to maintain a military force able to deploy to forward sites without undue risk of personnel developing dental emergencies while in the field. Air Force dentists continuously weigh whether to watch or restore incipient lesions with the patients' probability of being deployed, and judging how the patient's oral health and dietary practices will change once deployed. On which side a given dentist chooses to err will determine use of a preventive or restorative procedure. The rate with which dental caries progresses is slower now than in the past. The almost universal availability of fluoridated toothpaste has had a major impact on caries activity. But conditions while deployed, both physical and psychological, may alter the underlying pathophysiology. How well the dentist guesses (i.e., to go with preventive versus restorative treatment) can have serious consequences for both the deployed airmen and his ability to perform his job.

CONCLUSION

The presence or lack of water fluoridation on the sampled United States Air Force bases was not associated, at an level of statistical significance of 0.05, with any utilization rate differences of the studied preventive procedures. The procedures studied included the following: topical fluoride application, pit and fissure sealants, oral hygiene instruction, hygiene and soft tissue indices, diet planning, adult prophylaxis, and fluoride carriers/mouth protectors. Preventive dental procedures increased Air Force wide between 1995-1997, with the largest increase being seen for pit and fissure sealants. A question is raised about why a dentist chooses a restorative versus a preventive procedure. An interesting future study could address how the deployability of patients impacts a dentist's decision to chose between these treatment modalities.

APPENDIX 1

Appendix 1-A. Rate calculations and descriptive statistics for Oral Hygiene Instructions (OHI).

Base Pair	Fluoride Status	USAF Active Duty Population			Number of OH Instructions			Rates of Air Force OHI		
		1995	1996	1997	1995	1996	1997	1995	1996	1997
1	SUB	4992	5146	5146	11413	13237	13038	2.2863	2.5723	2.5336
2	SUB	2104	2098	2098	6112	5508	3798	2.9049	2.6254	1.8103
3	SUB	4189	4299	4194	14950	16662	14772	3.5689	3.8758	3.5222
4	SUB	3255	3255	3255	12209	11458	11360	3.7508	3.5201	3.4900
5	SUB	5993	6402	6121	27342	25968	20609	4.5623	4.0562	3.3669
6	SUB	7300	7300	7228	21257	20542	20316	2.9119	2.8140	2.8107
7	SUB	2761	2270	2548	7244	5221	6411	2.6237	2.3000	2.5161
8	SUB	3000	3163	3367	9724	9614	9074	3.2413	3.0395	2.6950
9	SUB	5538	5538	5538	15728	13252	13029	2.8400	2.3929	2.3527
1	OPT	7115	7213	6409	14670	13837	14873	2.0618	1.9183	2.3206
2	OPT	2161	2149	2537	6164	7803	6920	2.8524	3.6310	2.7276
3	OPT	4350	4350	3506	14018	13567	11766	3.2225	3.1189	3.3560
4	OPT	3591	3655	3655	10865	9826	11029	3.0256	2.6884	3.0175
5	OPT	1415	1541	1292	5624	6280	6858	3.9746	4.0753	5.3080
6	OPT	6772	6565	6565	21746	21069	21381	3.2112	3.2093	3.2568
7	OPT	2764	2741	2725	14972	14512	13279	5.4168	5.2944	4.8730
8	OPT	2094	2473	2766	5963	7541	7533	2.8477	3.0493	2.7234
9	OPT	4509	4135	3899	14661	11880	12885	3.2515	2.8730	3.3047

OHI Rate differences suboptimal -optimal bases

1995	1996	1997
0.2244	0.6539	0.2130
0.0526	-1.0056	-0.9173
0.3463	0.7569	0.1662
0.7252	0.8318	0.4725
0.5878	-0.0190	-1.9411
-0.2992	-0.3953	-0.4461
-2.7931	-2.9944	-2.3569
0.3937	-0.0098	-0.0284
-0.4115	-0.4801	-0.9520

Mean of rate diff	-0.358
Standard Deviation	1.064
Mann-Whitney Test	0.14
95% Confidence Interval	
lower	-0.607
upper	0.126
Minimun value	-2.994
Maximum value	0.832
Range	3.816

SUB = Suboptimally fluoridated water
OPT = Optimally fluoridated water

Appendix 1-B. Rate difference calculations and descriptive statistics for pit and fissure sealants.

Base Pair	Fluoride Status	USAF Active Duty Population			Number of Sealants			Rates of Sealants		
		1995	1996	1997	1995	1996	1997	1995	1996	1997
1	SUB	4992	5146	5146	400	654	755	0.0801	0.1271	0.1467
2	SUB	2104	2098	2098	1221	1790	1802	0.5803	0.8532	0.8589
3	SUB	4189	4299	4194	948	837	654	0.2263	0.1947	0.1559
4	SUB	3255	3255	3255	228	667	823	0.0700	0.2049	0.2528
5	SUB	5993	6402	6121	3571	3622	3053	0.5959	0.5658	0.4988
6	SUB	7300	7300	7228	1039	1127	1042	0.1423	0.1544	0.1442
7	SUB	2761	2270	2548	494	441	299	0.1789	0.1943	0.1173
8	SUB	3000	3163	3367	629	758	1129	0.2097	0.2396	0.3353
9	SUB	5538	5538	5538	372	477	1143	0.0672	0.0861	0.2064
1	OPT	7115	7213	6409	1118	1334	1942	0.1571	0.1849	0.3030
2	OPT	2161	2149	2537	732	686	524	0.3387	0.3192	0.2065
3	OPT	4350	4350	3506	539	188	877	0.1239	0.0432	0.2501
4	OPT	3591	3655	3655	1331	904	1214	0.3706	0.2473	0.3321
5	OPT	1415	1541	1292	212	642	567	0.1498	0.4166	0.4389
6	OPT	6772	6565	6565	2275	1427	1189	0.3359	0.2174	0.1811
7	OPT	2764	2741	2725	2876	2824	1542	1.0405	1.0303	0.5659
8	OPT	2094	2473	2766	387	620	1373	0.1848	0.2507	0.4964
9	OPT	4509	4135	3899	912	1402	1486	0.2023	0.3391	0.3811

Difference in Sealant Rates		
1995	1996	1997
-0.0770	-0.0579	-0.1563
0.2416	0.5340	0.6524
0.1024	0.1515	-0.0942
-0.3006	-0.0424	-0.0793
0.4460	0.1491	0.0599
-0.1936	-0.0630	-0.0370
-0.8616	-0.8360	-0.4485
0.0249	-0.0111	-0.1611
-0.1351	-0.2529	-0.1747

Mean	-0.06
Standard deviation	0.33
Paired t-test p value	0.359
95% Confidence Interval	
lower limit	-0.192
upper limit	0.072
Minimum value	-0.862
Maximum value	0.652
Range	1.510

SUB = Suboptimally fluoridated water
OPT = Optimally fluoridated water

Appendix 1-C. Rate difference calculations and descriptive statistics for topical fluoride treatments.

Base	Fluoride	USAF AD Population			Number of Fluoride Treatment			Rates of fluoride treatment		
Pair	Status	1995	1996	1997	1995	1996	1997	1995	1996	1997
1	SUB	4992	5146	5146	2825	1980	2677	0.5659	0.3848	0.5202
2	SUB	2104	2098	2098	1755	2082	2202	0.8341	0.9924	1.0496
3	SUB	4189	4299	4194	4239	5678	5821	1.0119	1.3208	1.3879
4	SUB	3255	3255	3255	3325	3026	2527	1.0215	0.9296	0.7763
5	SUB	5993	6402	6121	5020	4595	4852	0.8376	0.7177	0.7927
6	SUB	7300	7300	7228	1166	1092	3353	0.1597	0.1496	0.4639
7	SUB	2761	2270	2548	2321	1533	2015	0.8406	0.6753	0.7908
8	SUB	3000	3163	3367	2157	2409	2843	0.7190	0.7616	0.8444
9	SUB	5538	5538	5538	3614	3139	3752	0.6253	0.5668	0.6775
1	OPT	7115	7213	6409	5307	4724	4498	0.7459	0.6549	0.7018
2	OPT	2161	2149	2537	740	1996	2227	0.3424	0.9288	0.8778
3	OPT	4350	4350	3506	3551	3555	3448	0.8163	0.8172	0.9835
4	OPT	3591	3655	3655	3104	3072	2911	0.8644	0.8405	0.7964
5	OPT	1415	1541	1292	1755	2235	2178	1.2403	1.4504	1.6858
6	OPT	6772	6565	6565	8008	8525	7847	1.1825	1.2986	1.1953
7	OPT	2764	2741	2725	1235	2405	2607	0.4468	0.8774	0.9567
8	OPT	2094	2473	2766	1696	2014	1951	0.8099	0.8144	0.7054
9	OPT	4509	4135	3899	3366	3230	4194	0.7465	0.7811	1.0757

Topical Fluoride rate differences				
1995	1996	1997		
-0.17998	-0.27016	-0.18162	Mean	-0.156
0.49169	0.06357	0.17176	Standard Deviation	0.444
0.19561	0.50353	0.40448	Paired t-test p-value	0.057
0.15712	0.08915	-0.02010	95% Confidence Interval	
-0.40264	-0.73261	-0.89308	Lower	-0.330
-1.02279	-1.14896	-0.73139	upper	0.019
0.39382	-0.20209	-0.16588	Minimum value	-1.149
-0.09093	-0.05278	0.13902	Maximum value	0.504
-0.12122	-0.21433	-0.39816	Range	-1.653

SUB= Suboptimally fluoridated water
OPT = Optimally fluoridated water

Appendix 1-D. Rate difference calculations and descriptive statistics for adult prophylaxis.

Base Pair	Fluoride Status	USAF AD Population 1995	1996	1997	Number of Adult Prophylaxis 1995	1996	1997	Rate of Adult Prophylaxis 1995	1996	1997
1	SUB	4992	5146	5146	4258	5253	5419	0.8530	1.0208	1.0531
2	SUB	2104	2098	2098	2245	2287	2287	1.0670	1.0901	1.0901
3	SUB	4189	4299	4194	5958	6386	5983	1.4223	1.4855	1.4266
4	SUB	3255	3255	3255	4281	4257	3714	1.3152	1.3078	1.1410
5	SUB	5993	6402	6121	6339	5570	5811	1.0577	0.8700	0.9494
6	SUB	7300	7300	7228	8506	7457	7026	1.1652	1.0215	0.9721
7	SUB	2761	2270	2548	2522	1820	2369	0.9134	0.8018	0.9297
8	SUB	3000	3163	3367	3441	3319	3714	1.1470	1.0493	1.1031
9	SUB	5538	5538	5538	5985	5098	5597	1.0807	0.9205	1.0107
1	OPT	7115	7213	6409	5598	4982	4490	0.7868	0.6907	0.7006
2	OPT	2161	2149	2537	2495	2743	2277	1.1546	1.2764	0.8975
3	OPT	4350	4350	3506	5102	4960	4084	1.1729	1.1402	1.1649
4	OPT	3591	3655	3655	4183	4054	3619	1.1649	1.1092	0.9902
5	OPT	1415	1541	1292	2335	2535	2724	1.6502	1.6450	2.1084
6	OPT	6772	6565	6565	7671	8226	7819	1.1328	1.2530	1.1910
7	OPT	2764	2741	2725	5700	5291	5064	2.0622	1.9303	1.8583
8	OPT	2094	2473	2766	2541	2837	2624	1.2135	1.1472	0.9487
9	OPT	4509	4135	3899	4661	3849	4444	1.0337	0.9308	1.1398

Prophy rate difference (sub-opt)

1995	1996	1997
0.0662	0.3301	0.3525
-0.0875	-0.1863	0.1926
0.2494	0.3452	0.2617
0.1504	0.1987	0.1509
-0.5924	-0.7750	-1.1590
0.0325	-0.2315	-0.2190
-1.1488	-1.1286	-0.9286
-0.0665	-0.0979	0.1544
0.0470	-0.0103	-0.1291

Mean of rate diff for prophies	-0.155
Standard Deviation	0.475
Mann Whitney test	0.080
95% Confidence Interval	
Lower limit	-0.216
Upper limit	0.016
Minimum Value	-1.159
Maximum Value	0.353
Range	-1.512

SUB = Suboptimally fluoridated water
OPT = Optimally fluoridated water

Appendix 1-E. Rate difference calculations and descriptive statistics for diet planning.

Base Pair	Fluoride Status	USAF Active Duty Population 1995	1996	1997	Number of Diet Plans 1995	1996	1997	Rates of Diet Planning 1995	1996	1997
1	SUB	4992	5146	5146	1	1	3	0.00020	0.00019	0.00058
2	SUB	2104	2098	2098	2	0	0	0.00095	0.00000	0.00000
3	SUB	4189	4299	4194	1	13	1	0.00024	0.00302	0.00024
4	SUB	3255	3255	3255	2	0	0	0.00061	0.00000	0.00000
5	SUB	5993	6402	6121	53	5	3	0.00884	0.00078	0.00049
6	SUB	7300	7300	7228	5	10	11	0.00068	0.00137	0.00152
7	SUB	2761	2270	2548	0	4	1	0.00000	0.00176	0.00039
8	SUB	3000	3163	3367	2	3	2	0.00067	0.00095	0.00059
9	SUB	5538	5538	5538	482	44	37	0.08704	0.00795	0.00668
1	OPT	7115	7213	6409	3	5	1	0.00042	0.00069	0.00016
2	OPT	2161	2149	2537	0	4	2	0.00000	0.00186	0.00079
3	OPT	4350	4350	3506	404	247	120	0.09287	0.05678	0.03423
4	OPT	3591	3655	3655	0	0	2	0.00000	0.00000	0.00055
5	OPT	1415	1541	1292	4	2	0	0.00283	0.00130	0.00000
6	OPT	6772	6565	6565	1323	1723	1479	0.19536	0.26245	0.22529
7	OPT	2764	2741	2725	136	2	0	0.04920	0.00073	0.00000
8	OPT	2094	2473	2766	0	0	0	0.00000	0.00000	0.00000
9	OPT	4509	4135	3899	1	6	6	0.00022	0.00145	0.00154

Diet planning rate differences 1995	1996	1997
-0.00022	-0.0005	0.00043
0.00095	-0.0019	-0.0008
-0.09263	-0.0538	-0.034
0.00061	0	-0.0005
0.00602	-0.0005	0.00049
-0.19468	-0.2611	-0.2238
-0.04920	0.001	0.00039
0.00067	0.001	0.00059
0.08681	0.0065	0.00514

Mean of rate differences	-0.00070
Standard Deviation	0.18900
Mann Whitney Test	0.70000
95% Confidence Interval	
lower limit	-0.00106
upper limit	0.00037
Minimum value	-0.26110
Maximum Value	0.87010
Range	1.13000

SUB = Suboptimally fluoridated water
OPT = Optimally fluoridated water

Appendix 1-F. Rate difference calculations and descriptive statistics for oral hygiene/soft tissue indices.

Base	Fluoride	USAF AD Population			Number of hygiene indices			Rate of Air Force Indicies		
Pair	Status	1995	1996	1997	1995	1996	1997	1995	1996	1997
1	SUB	4992	5146	5146	50223	64916	64342	10.0607	12.6148	12.5033
2	SUB	2104	2098	2098	18601	25713	25810	8.8408	12.2560	12.3022
3	SUB	4189	4299	4194	31470	59726	55041	7.5125	13.8930	13.1237
4	SUB	3255	3255	3255	37791	29780	24942	11.6101	9.1490	7.6627
5	SUB	5993	6402	6121	33573	51260	57612	5.6020	8.0069	9.4122
6	SUB	7300	7300	7228	77624	76652	72209	10.6334	10.5003	9.9902
7	SUB	2761	2270	2548	20203	16348	29273	7.3173	7.2018	11.4886
8	SUB	3000	3163	3367	20306	31871	36765	6.7687	10.0762	10.9192
9	SUB	5538	5538	5538	57323	54405	50475	10.3508	9.8239	9.1143
1	OPT	7115	7213	6409	55719	57334	57482	7.8312	7.9487	8.9689
2	OPT	2161	2149	2537	11487	22856	23218	5.3156	10.6356	9.1518
3	OPT	4350	4350	3506	43920	48627	40828	10.0966	11.1786	11.6452
4	OPT	3591	3655	3655	40748	39298	39949	11.3473	10.7518	10.9300
5	OPT	1415	1541	1292	10230	20230	23868	7.2297	13.1278	18.4737
6	OPT	6772	6565	6565	45030	81760	78657	6.6494	12.4539	11.9813
7	OPT	2764	2741	2725	35486	38666	45030	12.8386	14.1065	16.5248
8	OPT	2094	2473	2766	16470	21312	22337	7.8653	8.6179	8.0756
9	OPT	4509	4135	3899	67890	66767	73179	15.0566	16.1468	18.7687

Hygiene indices rate differences		
1995	1996	1997
2.2295	4.6661	3.53435
3.52518	1.6203	3.15044
-2.584	2.7144	1.47857
0.26288	-1.6028	-3.2673
-1.6276	-5.121	-9.0615
3.98399	-1.9536	-1.9911
-5.5214	-6.9048	-5.0362
-1.0967	1.4583	2.84366
-4.7057	-6.3229	-9.6544

Mean of rate differences	-1.290
Standard Deviation	4.170
Paired t-test	0.119
95% Confidence Interval	
Lower Limit	-2.951
Upper limit	0.353
Maximum value	-9.654
Minimum value	4.667
Range	14.321

SUB =Suboptimally fluoridated water

OPT = Optimally fluoridated water

Appendix 1-G. Rate difference calculations and descriptive statistics for fluoride carriers/mouth protectors.

Base Pair	Fluoride Status	USAF Active Duty Population 1995	1996	1997	Number of Carriers 1995	1996	1997	Rate of Air Force Carriers 1995	1996	1997
1	SUB	4992	5146	5146	41	42	43	0.0082	0.0082	0.0084
2	SUB	2104	2098	2098	69	64	91	0.0328	0.0305	0.0434
3	SUB	4189	4299	4194	93	185	66	0.0222	0.0430	0.0157
4	SUB	3255	3255	3255	80	94	83	0.0246	0.0289	0.0255
5	SUB	5993	6402	6212	2857	3760	1813	0.4767	0.5873	0.2919
6	SUB	7300	7300	7228	133	44	35	0.0182	0.0060	0.0048
7	SUB	2761	2270	2548	53	69	89	0.0192	0.0304	0.0349
8	SUB	3000	3163	3367	21	27	45	0.0070	0.0085	0.0134
9	SUB	5538	5538	5538	100	90	95	0.0181	0.0163	0.0172
1	OPT	7115	7213	6409	20	9	27	0.0028	0.0012	0.0042
2	OPT	2161	2149	2537	41	69	57	0.0190	0.0321	0.0225
3	OPT	4350	4350	3506	39	16	15	0.0090	0.0037	0.0043
4	OPT	3591	3655	3655	69	27	42	0.0192	0.0074	0.0115
5	OPT	1415	1541	1292	45	252	153	0.0318	0.1635	0.1184
6	OPT	6772	6565	6565	185	35	275	0.0273	0.0053	0.0419
7	OPT	2764	2741	2725	57	37	53	0.0206	0.0135	0.0194
8	OPT	2094	2473	2766	28	45	34	0.0134	0.0182	0.0123
9	OPT	4509	4135	3899	44	39	61	0.0098	0.0094	0.0156

Carrier rate differences (sub-opt) 1995	1996	1997
0.0054	0.0069	0.00414
0.01382	-0.0016	0.02091
0.01324	0.0394	0.01146
0.00536	0.0215	0.01401
0.4449	0.4237	0.17343
-0.0091	0.0007	-0.037
-0.0014	0.0169	0.01548
-0.0064	-0.0097	0.00107
0.0083	0.0068	0.00151

Mean	0.04384
Standard Deviation	0.117855
Mann Whitney test	0.11
95% Confidence Interval	
lower limit	-0.0006
upper limit	0.0883
Minimum value	-0.037
Maximum value	0.449
Range	0.48

SUB = Suboptimally fluoridated water
OPT = Optimally fluoridated water

Appendix 2. Descriptive statistics of preventive procedures by individual fiscal year and as a pooled sample.

Preventive Procedure		1995	1996	1997	3yr Total
	Sample Size	9	9	9	27
	Distribution	Normal	Normal	Normal	Normal
Topical Fluoride	Mean	-0.064	-0.218	-0.186	-0.156
Treatments	Stnd Dev	0.459	0.482	0.426	0.444
	95% CI				
	lower limit	-0.417	-0.588	-0.514	-0.332
	upper limit	0.289	0.152	0.141	0.019
	P-value	0.685	0.211	0.226	0.057
	Sample Size	9	9	9	27
	Distribution	Not Normal	Normal	Normal	Normal
Adult Prophylaxis	Mean	-0.145	-0.173	-1.147	-0.155
	Stnd Dev	0.438	0.496	0.542	0.476
	95% CI				
	lower limit	-0.335	-0.554	-0.563	-0.216
	upper limit	0.142	0.209	0.270	0.016
	P-value	0.380	0.320	0.440	0.080
	Sample Size	9	9	9	27
	Distribution	Not normal	Not normal	Not normal	Not normal
Fluoride Carriers	Mean	0.05	0.06	0.03	0.04
	Stnd Dev	0.05	0.14	0.06	0.12
	95% CI				
	lower limit	-0.01	-0.01	0.02	0.00
	upper limit	0.02	0.03	0.03	0.01
	P-value	0.60	0.22	0.49	0.11
	Sample Size	9	9	9	27
	Distribution	normal	normal	normal	Normal
Hygiene/Soft Tissue	Mean	-0.6100	-1.2700	-2.0300	-1.2990
Indices	Stnd Dev	3.4100	4.1800	5.1900	4.1760
	95% CI				
	lower limit	-3.2400	-4.4800	-5.9600	-2.9510
	upper limit	2.0100	1.94	1.9600	0.3530
	P-value	0.6030	0.3900	0.2800	0.1200

Appendix 2. Descriptive statistics of preventive procedures by individual fiscal year and as a pooled sample (cont).

Preventive Procedure		1995	1996	1997	3 yr total
	Sample Size	9	9	9	27
	Distribution	Not normal	Not normal	Not normal	Not normal
Diet Planning	Mean	0.0600	-0.0344	-0.0280	-0.0007
	Stnd Dev	0.3110	0.0869	0.0743	0.1890
	95% CI				
	lower limit	-0.0491	-0.1467	-0.1268	-0.0010
	upper limit	0.0008	0.0000	0.0004	0.0004
	P-value	0.8253	0.0469	0.1853	0.0700
	Sample Size	9	9	9	27
	Distribution	Normal	Normal	Normal	Normal
Pit and Fissure	Mean	-0.084	-0.480	-0.049	-0.060
Sealants	Stnd Dev	0.371	0.368	0.297	0.340
	95% CI				
	lower limit	-0.369	-0.330	-0.277	-0.192
	upper limit	0.201	0.235	0.180	0.072
	P-value	0.518	0.708	0.636	0.359
	Sample Size	9	9	9	27
	Distribution	Not normal	Normal	Normal	Not normal
Oral Hygiene	Mean	-0.130	-0.300	-0.643	-0.358
Instructions	Stnd Dev	1.067	1.186	0.990	1.064
	95% CI				
	lower limit	-0.950	-1.212	-1.404	-1.554
	upper limit	0.690	0.612	0.118	2.482
	P-value	0.790	0.480	0.090	0.142

REFERENCES

Air Force Association. 1995. Air Force Almanac 1995. *Air Force Magazine*, May.

_____. 1996. Air Force Almanac 1996. *Air Force Magazine,* May.

_____. 1997. Air Force Almanac 1997. *Air Force Magazine,* May.

Andlaw, R. J. 1978. Oral hygiene and dental caries: A review. *International Dental Journal* 28: 1-6.

Ast, D. B., and E. R. Schessinger. 1956. The conclusion of a ten year study of water fluoridation. *American Journal of Public Health* 46(3): 1265-271.

Ast, D. B., and H. C. Chase. 1953. Newburgh-Kingston caries fluoride study. IV. Dental findings after six years of water fluoridation. *Oral Surgery, Oral Medicine and Oral Pathology* 6: 114 -123.

Anusavice, Kenneth J. 1995. Treatment regimens in preventive and restorative dentistry. *Journal of the American Dental Association* 126(6): 727-739.

Beltran, Eugenio D., and Brian A. Burt. 1988. The pre- and posteruptive effects of fluoride in the caries decline. *Journal of Public Health Dentistry* 48(4): 233-240.

Bibby, Basil G. 1944. Use of fluorides in the prevention of dental caries. I. Rationale and approach. *Journal of the American Dental Association* 31(2): 228-236.

Brown, L. Jackson, and Robert H. Selwitz. 1995. The impact of recent changes in the epidemiology of dental caries on guidelines for the use of dental sealants. *Journal of Public Health Dentistry* 55(5): 274-291.

Burt, B. A., S. A. Eklund, K. J. Morgan, F. E. Larkkin, K. E. Guire, L. O. Brown, and J. A. Weintraub. 1988. The effects of sugar intake and frequency of ingestion on dental caries increment in a three-year longitudinal study. *Journal of Dental Research* 67(11): 1422-1429.

Chisick, Michael C., F. R. Pointdexter, and A. K. York. 1998. Dental sealants: prevalence and need in U.S. military recruits. *Military Medicine* 163(6): 386-388.

Cox, Gerald J. 1940. The fluorine and dental caries problem. *Journal of the American Dental Association* 27: 1107-1114.

Cox, Gerald J., Margaret C. Matuschak, Sara F. Dixon, Mary L. Dodds, and W. E. Walker. 1939. Experimental dental caries IV. Fluorine and its relation to dental caries." *Journal of Dental Research* 18: 481-489.

Cueto, Eriberto I., and Michael G. Buonocore. 1967. Sealing of pi and fissures with an adhesive resin: Its use in caries prevention. *Journal of the American Dental Association* 75(1): 121-128.

Fancher, James P. Base Fluoridation Survey. 1997. Memorandum to United States Air Force Headquarters, Office of the Surgeon General, Dental Directorate 14 May.

Foreman, Frank J. 1994. Sealant prevalence and indication in a young military population. *Journal of the American Dental Association* 125:182-185.

Heller, K. E., S. G. Reed, F. W. Bruner, S. A. Eklund, and B. A. Burt. 1995. Longitudinal evaluation of sealing molars with and without incipient dental caries in a public health program. *Journal of Public Health Dentistry* 55(3): 148-153.

Hunter, Peter B. 1988. Risk factors in dental caries. *International Dental Journal* 38: 211-217.

Kidd, Edwina A. M., and Sally Joyston-Bechal. 1997. *Essentials of Dental Caries the Disease and Its Management.* 2nd Edition. Oxford: Oxford University Press.

Krasse, Bo. 1984. Can microbiological knowledge be applied in dental practice for the treatment and prevention of caries? *Journal of Public Health Dentistry* 48(4): 233-240.

_____. 1995. From the art of filling teeth to the science of dental caries prevention: A personal review. *Journal of Public Health Dentistry* 56(5), Special Issue: 271-276.

Lufkin, Arthur Ward. 1948. *A History of Dentistry.* Philadelphia: Lea and Febiger.

Manton, David J., and Louise Brearley Messer. 1995. Pit and fissure sealants: Another major cornerstone in preventive dentistry. *Australian Dental Journal* 40(1): 22-29.

Meyer, Daniel M., J. W. Simecek, M. E. Stone, and D. C. C. Alexander. 1966. The evaluation of a managed dental delivery concept. *Military Medicine* 161(7): 401-406.

Mundorff-Shrestha, S. A., J. D., B. Featherstone, A. D. Eisenberg, E. Cowles, M. E. J. Cruzon, M. A. Espeland, and C. E. Shields. 1994. Cariogenic potential of food. *Caries Research* 28:106-115.

Newbrun, Ernest. 1989. *Cariology.* 3rd Edition. Berlin: Quintessence Publications Company, Inc.

_____. 1992. Preventing dental caries: current and prospective strategies. *Journal of the American Dental Association* 123(5): 68-73.

O'Mullane, D. 1995. Can prevention eliminate caries? *Advances in Dental Research* 9(2): 106-109.

Reeves, Thomas G. 1995. Engineering and administrative recommendations for water fluoridation, 1995. *Morbidity and Mortality Weekly Report* 44: No. RR-13.

_____. 1995. *Water Fluoridation: A Manual for Engineers and Technicians.* Atlanta: United States Department of Health and Human Services, Public Health Service, Center for Disease Control and Prevention.

Ring, Marvin E. 1985. *Dentistry: An Illustrated History.* St Louis: C. V. Mosby Company.

Rirodan, Paul J. 1993. Fluoride supplements in caries prevention: A literature review and proposal for a new dosage schedule. *Journal of Public Health Dentistry* 53(3): 174-189.

Ripa, L. W. 1993. A half-century of community water fluoridation in the United States: review and commentary. *Journal of Public Health Dentistry* 53(1): 17-44.

_____. 1993. Sealants revisited: an update of the effectiveness of pit and fissure sealants. *Caries Research* 27 (Supplement 1): 77-82.

Rozier, R. Gary. 1995. Reaction paper. The impact of recent changes in the epidemiology of dental caries on guidelines for the use of dental sealants. Epidemiology perspective. *Journal of Public Health Dentistry* 55(5): 292-301.

Ryge, Gunnar, and Eva J. Mertz-Fairherst. 1987. Pit and fissure sealants. In *Clinical Dentistry.* Philadelphia: J. B. Lipponcott Company.

Selwitz, R. H., D. M. Winn, A. Kingman, and G. R. Zion. 1996. The prevalence of dental sealants in the U.S. population: findings from NHANES III, 1988-1991. *Journal of Dental Research* 75(Special Issue): 652-660.

Shafer, William G., Maynard K. Hine, and Barnet M. Levy. 1974. *A Textbook of Oral Pathology.* 3rd Edition. Philadelphia: W. B. Saunders Company.

Siegal, Mark. 1995. Promotion and use of pit and fissure sealants: an introduction to the special issue. *Journal of Public Health Dentistry* 55(5): 259-260.

Soderholm, K. J. M. 1995. Reactor Paper: The impact of recent changes in the of epidemiology of dental caries on guidelines for the use of dental sealants. Clinical perspectives. *Journal of Public Health Dentistry* 55(5): 302-311.

Taylor, M. 1997. Active Air Force –Airmen demographic data age, 31 Aug97 AAE <*http://www.afpc.af.mil/analysis/demograf/AGEGROUP.html*> 17 September.

_____. 1997. Current active Air Force officers – age- 31 Aug 97 BAE. <*http://www.afpc.af.mil.analysis/demograf/AGECROUP.html* > 17 September.

Trube, Thomas F. 1991. Dental sealants. *New York State Dental Journal* 57(2): 25-27.

Waggoner, William G., and Mark Siegal. 1996. Pit and fissure sealant application. *Journal of the American Dental Association* 127(3): 351-361.

White, Benjamin, Alexia A. Antczak-Bouckoms, and Milton C. Weinstein. 1989. Issues in the economic evaluation of community water fluoridation. *Journal of Dental Education* 53(11): 646-657.

York, Andrew K., F. R. Pointdexter, and M. C. Chisick. 1995. *1994 Tri-service Comprehensive Oral Health Survey. Active Duty Report.* NDRI No. PR-9503. Washington, D. C.: Office of the Secretary, The Department of Defense.

_____. 1995. *1994 Tri-Service Comprehensive Oral Health Survey, Recruit Report.* NDRI No. PR-9502. Washington, D. C.: Office of the Secretary, The Department of Defense.

York, A. K., and J. Stephen Arthur. 1993. Reasons for placement and replacement of dental restorations in the United States Navy Dental Corps. *Operative Dentistry* 18: 203-208.

Vita

Irene G. Bober-Moken was born in Elizabeth, New Jersey on 3 January 1952, the third daughter of Irene Rohrbeck Bober and Alphonse Joseph Bober. After completing her work at Saint Mary of the Assumption High School, Elizabeth, New Jersey in 1969, she entered Douglass College, at New Brunswick, New Jersey. She received the degree of Bachelor of Arts with a major in Biological Science from Douglass College 1973, graduating cum laude. Following a year as a Fellow under EPA sponsorship, she received her Master of Science in Environmental Science from Rutgers University, New Brunswick, New Jersey. She served as a Radiation Health Physicist for the District of Columbia from 1974-1975 and for the State of New Jersey 1975-1976. After her marriage to Richard John Moken in 1975, she then entered the New Jersey Dental School, graduating in May 1981. She joined the United States Air Force Dental Corps in 1981, attending a General Practice Residency at Malcolm Grow Medical Center, Washington, DC. Upon completion, she was assigned to Dover Air Force Base, Delaware (1981-1982) with subsequent assignments to Howard Air Base, Republic of Panama (1983-1987), Dover AFB, Delaware (1987-1992); and Scott AFB, Illinois (1992-1997). She was elected a Fellow of the Academy of General Dentistry in 1983 and a Fellow of the Academy of Dentistry International in 1994. She is the mother of two sons, James Andrew Moken born in 1985 and Christopher Edward Moken born in 1988.

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