

EFFECTS OF WAXED DENTAL FLOSS INCLUSION IN THE
REGIMEN OF ORAL HYGIENE OF ANTARCTIC PERSONNEL

by

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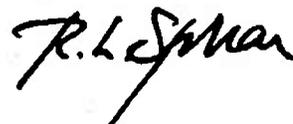
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SUMMARY PAGE

THE PROBLEM

To evaluate the effectiveness of dental floss on oral hygiene and gingival health in an effort to assess its value in impeding the development and progress of periodontal disease.

FINDINGS

Proper use of dental floss in conjunction with other home care procedures aided in achieving and maintaining a higher level of oral hygiene and gingival health than was attained in an identical regimen without dental floss. Serially recorded oral hygiene indices suggested that sustained maintenance of improved oral hygiene and gingival health apparently require periodic reinforcement of motivational stimuli.

APPLICATION

Personnel efficiency which has been reduced due to periodontal disease can be improved through the proper use of dental floss in conjunction with other home care procedures. The degree to which periodontal disease can be reduced appears relative to the nature of motivation, skill and knowledge instilled in the patient. Some form of improved motivational input appears essential for maintenance of an otherwise unattainable higher level of gingival health.

ADMINISTRATIVE INFORMATION

This investigation was conducted as part of Bureau of Medicine and Surgery Research Unit MR041.20-02-6025B3IJ. The present report is Number four on this work unit. It was submitted for review on 13 March 1974, approved for publication on 27 March 1974, and designated as NavSubMedRschLab Report No. 782.

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ABSTRACT

Oral health indices were compared for two groups of subjects in Antarctic personnel. One group was trained to use dental floss, the other was not.

Both groups demonstrated significant reductions in dental debris relative to their respective baseline levels. The subjects using dental floss showed significant improvements in gingival health when compared to the group of non-floss users.

Professional guidance was rendered at monthly examinations. Oral health indices showed progressive improvement during the wintering-over period but regressed toward baseline levels just prior to leaving the Antarctic. This corroborates results of other studies and re-emphasized the need for improved motivational stimulation if high levels of personal oral hygiene are to be maintained in personnel who are subjected to operationally induced stress factors.

Statistical inference drawn from the data gathered suggests that dental floss, used regularly as an adjunct to other home care procedures, can aid in achieving and maintaining a significantly higher level of gingival health than is attainable without the use of dental floss.

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INTRODUCTION

Although preventive dentistry is an essential and integral part of current Navy dental practice, the greater part of our resources are expended on examining, diagnosing, and treating operative and surgical oral health problems. The efforts and resources utilized toward attainment of optimum combat readiness by removing caries are often compromised due to periodontally related problems, which presumably could be attenuated through preventive care. Gingival disease also has the potential of reducing personnel efficiency. Epidemiological studies^{1,2,3} have conclusively shown that a direct relationship exists between oral hygiene and periodontal health: e.g., localized gingivitis will frequently develop in only 4-11 days and generalized gingivitis within 2-3 weeks, when oral hygiene procedures are suspended.⁴ Resumption of oral hygiene procedures then results in a dramatic improvement in oral tissue health.⁴ Stanmeyer,⁵ reported a decrease in gingival inflammation following increased frequency of toothbrushing. Other authors^{6,7} have indicated that dental floss is needed in addition to toothbrushing to remove bacterial plaque from otherwise inaccessible areas.

Great emphasis has been placed on brushing, flossing and the use of plaque disclosing agents to improve oral hygiene. Both active^{8,9,10,11,12} and passive^{8,11} motivational approaches have been suggested as subjective

factors which stimulate good oral hygiene practice.

Three Navy Dental Officers^{11,13,14} previously in Antarctica, where the U.S. Navy provided year-round dental support to Antarctic-based personnel, noted similar patterns in oral hygiene during their respective one-year research programs. Oral hygiene initially improved among the subjects at the beginning of wintering-over isolation and then regressed prior to their departure from the Antarctic. Analogous findings were also reported by Miller,¹⁵ a Navy Dental Officer stationed at Diego Garcia, an isolated tropical atoll in the Indian Ocean.

The assigned responsibility of administering to the dental needs of civilian and naval personnel living at McMurdo Station, Antarctica, (during Operation Deep Freeze 1973) presented a unique opportunity for oral biological research. This study was undertaken to measure any benefits from the addition of dental floss usage to a prescribed, accepted, method of oral hygiene.

MATERIALS AND METHODS

Prior to Antarctic deployment, the Principal Investigator's diagnostic methodology was calibrated with that of colleagues at the Naval Submarine Medical Research Laboratory, Naval Submarine Base New London, Groton, Connecticut. Standardization of

diagnostic judgment was accomplished through clinical evaluation of patients utilizing the simplified debris index (DI-S) of Greene and Vermillion,¹⁶ the modified periodontal index of A. L. Russell (PI)¹⁷ and the periodontal disease index (PDI) of S. P. Ramfjord.¹⁸ The determinations for specific patients examined by three clinicians were compared. The patients were then recalled and jointly re-evaluated by the same clinicians to aid in developing more uniform clinical scoring.

The preliminary phase of the research program began at McMurdo Station, Antarctica. Baseline information for this all-volunteer male group included age, activity (environmental exposure)*, DI-S and PI. The DI-S scores were used to divide the subjects into categories according to debris scores as follows: excellent 0.0 - 0.16, good 0.16 - 0.32, fair 0.32 - 0.83 and poor 0.83 - 3.0. Two study groups were established (Group I, Floss Group; and Group II, Non-Floss Group) to effect a balanced distribution of men according to age, activity and DI-S scores (Table I)

No one using floss prior to the exam was accepted for the study group of 51

**Inside workers who were not exposed to the extreme environment except in transiting from one building to another, and outside workers who spent at least part of their work day operating mobile equipment or supporting other outdoor activity.*

men. All examinations and individual education procedures were performed by the same Dental Officer.

The second phase of the program commenced with each subject receiving a thorough prophylaxis using a Cavitron, Model 660, followed by a rotating rubber cup with pumice. Two bite-wing radiographs complemented a clinical examination for location of residual calculus, which was then removed with hand instruments. Individually, each subject received a lecture, instructions (both oral and written) and a demonstration on proper oral hygiene. Each subject was supplied with an Oral B-40 toothbrush, a disclosing tablet, and a tube of Crest toothpaste. The subject was then asked to brush his teeth as instructed. During this time each individual was closely observed to insure proper application of the Modified Stillman's Technique.¹⁹ Problem areas were checked by having each subject chew a disclosing tablet as instructed. Areas of difficulty were pointed out and instructions given to facilitate inclusion of the neglected areas in the new brushing technique. Subjects were instructed to brush at least once each day. They were instructed to chew a disclosing tablet once a week for five weeks to reinforce their ability to effectively practice the assigned hygiene technique. Only subjects in the Floss Group received a roll of waxed dental floss and individual lectures and instructions (both oral and written) on its proper use. Each

Table I. Characteristics of Study Groups at the Initial Exam

FLOSS GROUP					
	Start	Dropped	Finish	Out- side	In- Side
Selected (N)	24		21		
Average age	27.6		27.1		
Greene and Vermillion Score (DI-S)					
Excellent (0 - .166)	4	1	9		
Good (.167 - .500)	11		8		
Fair (.501 - .833)	6		4		
Poor (.834 - 3)	<u>3</u>	<u>2</u>	<u>0</u>		
	24	3	21		
Group mean score (DI-S)	.513		.314		
Environmental exposure				6	18
NON-FLOSS GROUP					
	Start	Dropped	Finish	Out- side	In- side
Selected (N)	27		25		
Average age	26.9		26.9		
Greene and Vermillion Score (DI-S)					
Excellent (0 - .166)	3		8		
Good (.167 - .500)	14	2	9		
Fair (.501 - .833)	9		7		
Poor (.834 - 3)	<u>1</u>	<u>1</u>	<u>1</u>		
	27	2	25		
Group mean score (DI-S)	.523		.403		
Environmental exposure				8	19

Floss Group subject was asked to use the floss as instructed. During the flossing procedure, the subjects were closely observed to insure "proper" flossing technique. "Proper" flossing was accomplished when the subject was proficient enough to pass the floss between the contacts of adjacent teeth and carry it slightly into the gingival sulcus. It was essential for a small portion of the facial and lingual surfaces of the tooth to be covered by the floss wrapped around the proximal surface as it was moved incisogingivally for six double strokes. Performance of all flossing procedures was to be accomplished without incurring damage to the soft tissue.

The following conditions were evaluated clinically and recorded at each monthly examination. Gingivitis was assessed according to PI and the degree of inflammation of the gingival tissues noted. A grade of 0 was given for the absence of gingivitis; 1 for a slight change in tissue color from coral pink or reddish pink, but not circumscribing the tooth; 2 for a change to deep red with edema of the tissue and completely surrounding the tooth; 6 for a change to purple red, with severe changes in the form of the tissue causing a break in the epithelial attachment and forming a pocket, and 8 for advanced destruction with loss of masticating function. Subjects also were examined to assess oral hygiene by the DI-S method. The clinical crown of the tooth was divided arbitrarily into three parts and scored as follows: 0 if no debris was found on the crown, 1 if deposits of debris were found in small amounts or covering the gingival one-third of the crown; 2 if

debris covered more than one-third but less than two-thirds of the crown surface; and 3 if deposits of debris covered more than two-thirds of the crown surface. Measurement of the crevice depth relative to the C-E junction was made in accordance with Ramfjord's method.

At the termination of the wintering-over period each subject was asked to indicate how closely he had adhered to the program. Frequency of flossing and brushing was recorded. The data was analyzed upon return to the Naval Submarine Medical Research Laboratory.

RESULTS

Mean scores for gingivitis and debris for each group were recorded monthly for five months after baseline determinations. Analysis of variance for each study group indicated occurrence of significant* (confidence level $\leq 5\%$, F-ratio) changes in both PI and DI-S levels during the winter-over period (Table II). Further analytical breakdown on a monthly basis demonstrated interesting patterns of index alteration (Table III, Figure 1).

The group using dental floss showed progressive reductions in both gingivitis (PI) and debris index scores, compared with baseline levels. The mean gingivitis (PI) score for the floss group reached a statistically significant level of improvement during the second

*Hereafter, "significant" refers to confidence levels $\leq 5\%$, and "very significant" refers to confidence levels $\leq 1\%$.

Table II. Analysis of Variance for Oral Health Indices During Entire Deployment Period.

FLOSS GROUP				
Russell's (PI) Index - Time Relationship				
Source of variance	Sum of squares	df	Mean square	f
Between groups (Mar thru Sep)	4.351	5	0.870	3.041*
Within groups (error)	30.682	107	0.286	
Total	35.033			
Greene-Vermillion (DI-S) Index - Time Relationship				
Source of variance	Sum of squares	df	Mean square	f
Between groups (Mar thru Sept)	1.987	5	0.397	8.446**
Within groups (error)	5.078	107	0.047	
Total	7.065			
NON-FLOSS GROUP				
Russell's (PI) Index - Time Relationship				
Source of variance	Sum of squares	df	Mean square	f
Between groups (Mar thru Sept)	1.985	5	0.397	3.007*
Within groups (error)	16.282	123	0.132	
Total	18.267			
Greene-Vermillion (DI-S) Index - Time Relationship				
Source of variance	Sum of squares	df	Mean square	f
Between groups (Mar thru Sept)	2.036	5	0.407	7.537**
Within groups (error)	6.763	123	0.054	
Total	8.799			

* Confidence level $\leq 5\%$

** Confidence level $\leq 1\%$

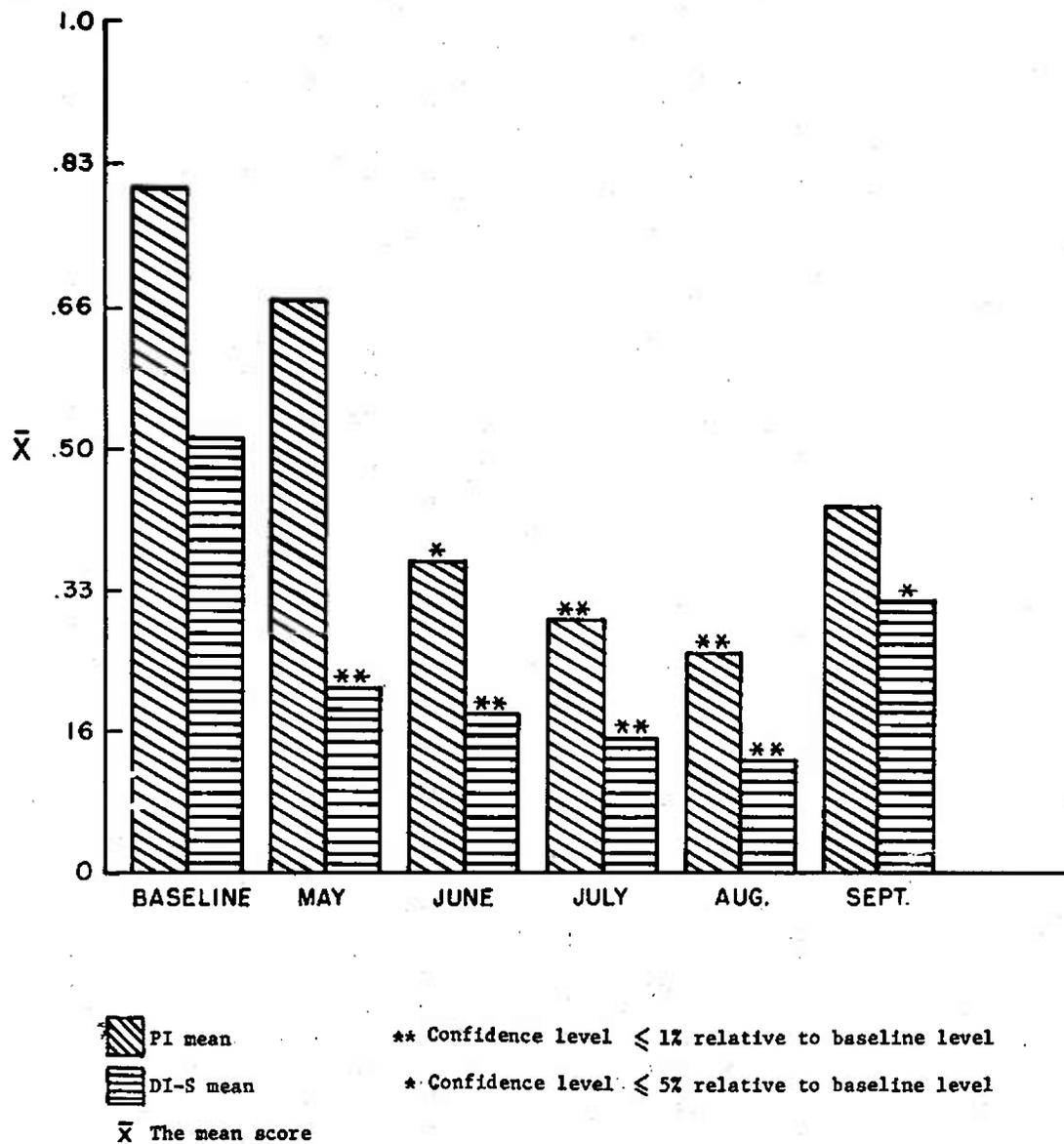


Fig. 1. Monthly mean gingivitis (PI) and debris (DI-S) scores for subjects using dental floss.

month, which was sustained until the last month. Decrease in mean score for debris (DI-S) in the floss group indicated very significant improvement in oral hygiene during the first month which was maintained until the last month. During the last month the mean indices for gingivitis (PI) and debris (DI-S) regressed toward their respective baseline values. The September debris score (DI-S), however, showed a smaller relative increase and retained significance over its baseline value.

The non-flossing group also demonstrated monthly improvement, relative to baseline determinations (Table III, Figure 2). Reduction in mean gingivitis (PI) score was less pronounced for this group and did not become statistically significant until the third month. Debris score-(DI-S) decrease in this group, however, was observed early, as in the floss group and it became statistically very significant in the first month, and remained so until the last month. In this group, only the debris index (DI-S) increased towards its baseline level in the last month, while the gingivitis (PI) score continued to show reduction in inflammation at the final month's examination.

The Standard Error of the Mean (SEm) was consistently lower in the debris (DI-S) determinations for both groups than the SEm for the gingivitis (PI) level (Table III). This suggests more reliability in the measurement for debris than in that for gingivitis.

Since the mean measure of crevice depths remained almost constant for both

groups throughout the entire study, a statistical analysis for change was not attempted.

Mean scores for gingivitis (PI) and debris (DI-S) levels in both groups were arranged for direct comparison (Table IV, Figures 3 and 4). It is apparent that gingivitis (PI) and debris (DI-S) scores decreased more in the floss group, relative to baseline values, than in the non-flossing group. The difference between mean scores for gingivitis (PI) during the second, third, and fourth months were statistically very significant. Debris (DI-S) levels in both groups, however, were found to parallel each other consistently throughout the study, with a slight suggestion of more improvement in the floss group.

DISCUSSION AND CONCLUSION

The statistical inference drawn from the data gathered in this study, indicates that those subjects using dental floss in addition to a prescribed method of oral hygiene achieved significantly greater reductions in gingivitis (PI), relative to non-floss users, in an otherwise identical regimen. It is interesting to note that, although a greater degree of gingivitis (PI) reduction was attained by the floss group, marked regression towards the baseline value occurred just prior to completion of the wintering-over period. The gingivitis (PI) level of the non-floss group, on the other hand, did not regress but showed slight, continuing improvement up to the conclusion of

Table III. Monthly Comparative Statistical Analyses Relative to Baseline Determinations

	FLOSS GROUP									
	Russell's (PI)					Greene and Vermillion (DI-S)				
	N	Mean	S.D.	SEm	F-ratio	N	Mean	S.D.	SEm	F-ratio
Baseline	21	0.782	0.687	0.149		25	0.513	0.272	0.059	
May	21	0.670	0.783	0.166	0.268	25	0.210	0.228	0.049	15.222**
June	19	0.366	0.325	0.074	5.785*	21	0.189	0.181	0.041	19.018**
July	16	0.288	0.236	0.059	7.540**	17	0.153	0.137	0.034	23.560**
August	15	0.252	0.214	0.055	8.279**	16	0.130	0.122	0.031	25.700**
September	21	0.425	0.554	0.120	3.433	25	0.314	0.266	0.058	5.763*
NON-FLOSS GROUP										
	Russell's (PI)					Greene and Vermillion (DI-S)				
	N	Mean	S.D.	SEm	F-ratio	N	Mean	S.D.	SEm	F-ratio
	Baseline	25	0.864	0.336	0.067		25	0.523	0.240	0.048
May	25	0.796	0.320	0.064	0.527	25	0.290	0.234	0.046	11.912**
June	21	0.710	0.418	0.091	1.921	21	0.195	0.167	0.036	27.244**
July	17	0.622	0.349	0.084	5.042*	17	0.202	0.197	0.047	20.800**
August	16	0.588	0.392	0.098	5.728*	16	0.195	0.219	0.054	19.425**
September	25	0.522	0.370	0.074	11.632**	25	0.403	0.294	0.058	2.452

*Confidence level $\leq 5\%$.

**Confidence level $\leq 1\%$.

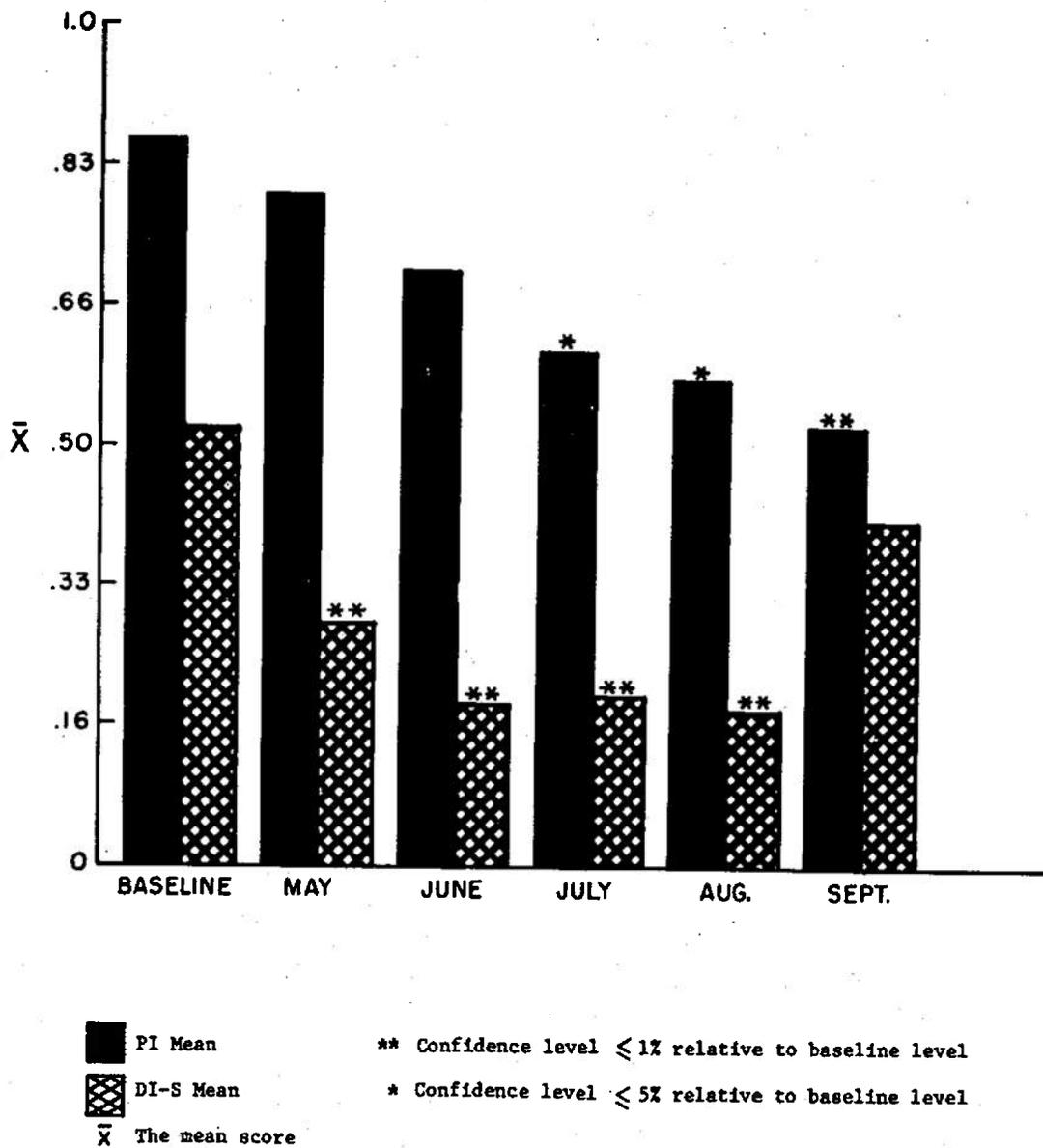


Fig. 2. Monthly mean gingivitis (PI) and debris (DI-S) scores for subjects not using dental floss but instructed in brushing technic.

Table IV. Monthly Comparative Statistical Analyses Between the Floss and Non-Floss Groups

RUSSEL'S (PI)			
	Floss Group	Non-Floss Group	
	Mean	Mean	F-ratio
Baseline	0.782	0.864	
May	0.670	0.796	0.598
June	0.366	0.710	8.295**
July	0.288	0.622	10.188**
August	0.252	0.588	8.568**
September	0.425	0.522	0.495
GREENE AND VERMILLION (DI-S)			
	Mean	Mean	F-ratio
Baseline	0.513	0.523	
May	0.210	0.290	1.333
June	0.189	0.195	0.000
July	0.153	0.202	0.724
August	0.130	0.195	1.031
September	0.314	0.403	1.151

**Confidence level \leq 1%.

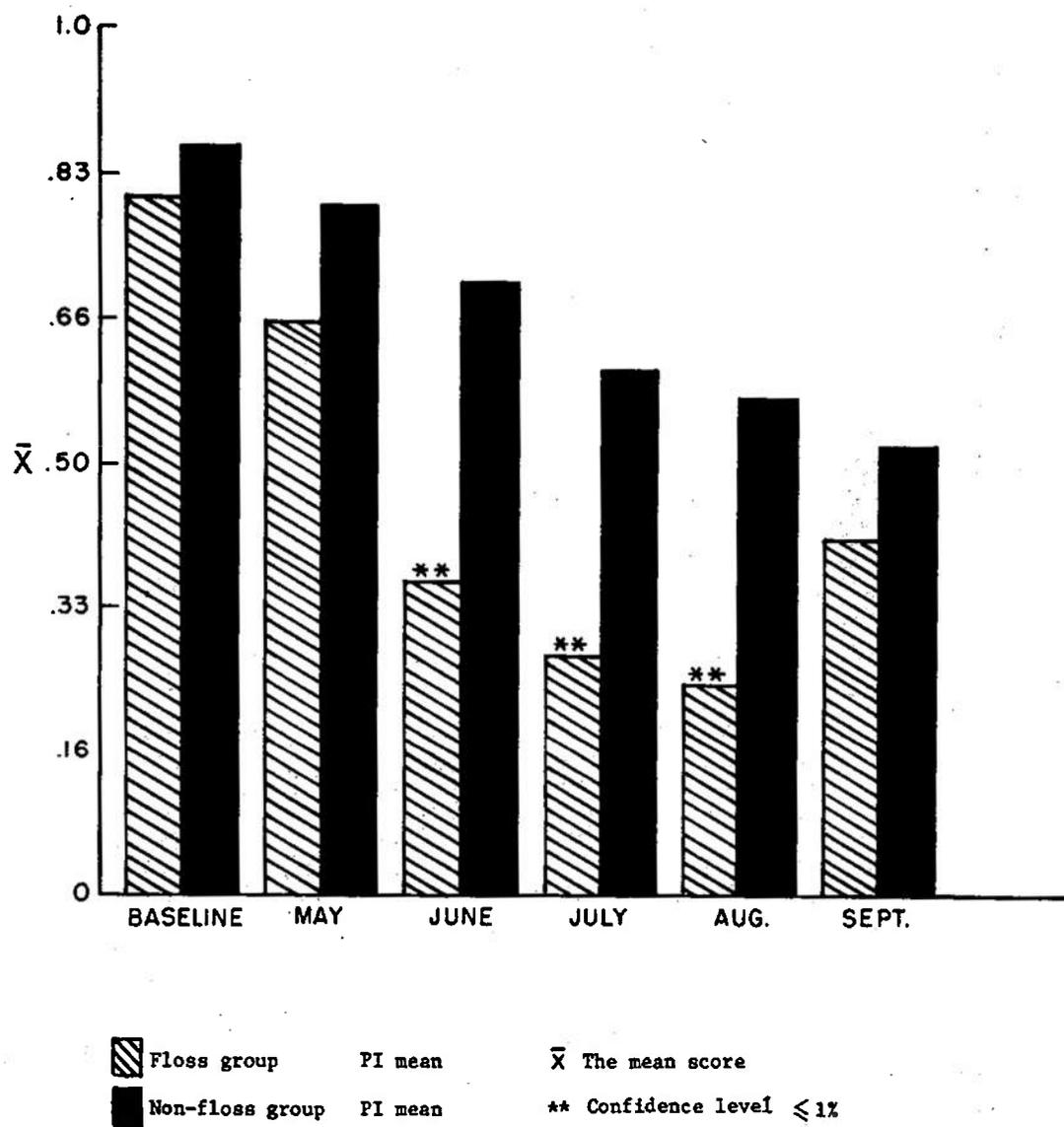


Fig. 3. Comparison of monthly mean gingivitis (PI) scores between the floss and non-floss groups.

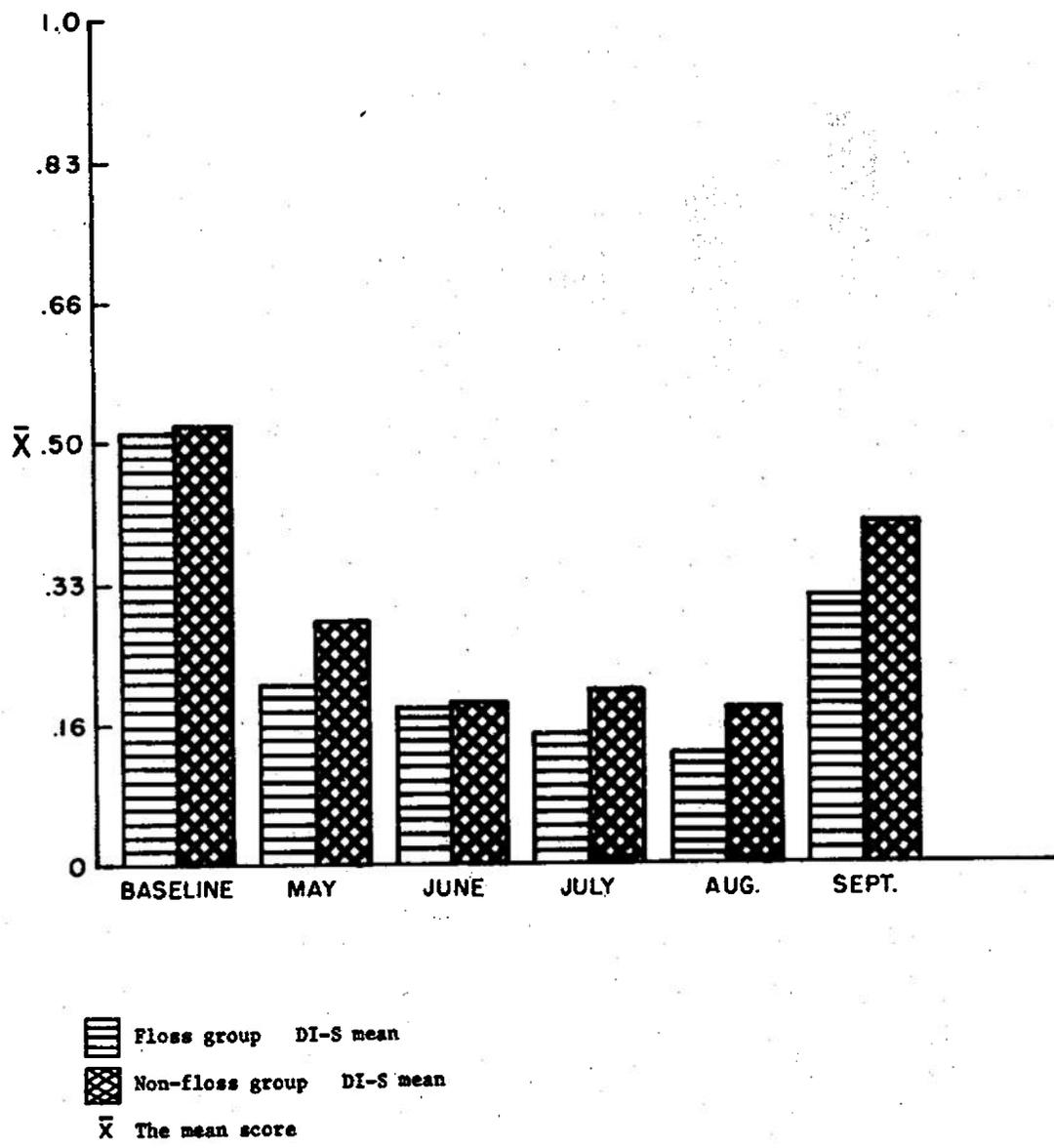


Fig. 4. Comparison of monthly mean debris (DI-S) scores between the floss and non-floss groups.

the study. However, the greater degree of reduction in gingivitis achieved by the floss group was never attained by the non-floss group.

The profile of debris variations showed an almost equal degree of significant debris reduction (DI-S) in both groups, when compared to their baseline scores, with parallel regression toward baseline values occurring just prior to completion of the wintering-over period.

The suggestion that the measurement for debris level is statistically more reliable than that for gingivitis is not surprising when one considers the relative mechanics of the two tests. Interpretation of gingivitis involves a subjective determination based upon tissue color and form. This factor notwithstanding, such assessments have shown remarkably good reproducibility between different investigators as well as within the same investigator.^{17,19} Design of the Navy Periodontal Disease Index has been based on such a technic of measurement.

The pattern of initial improvement followed by subsequent regression at the end of the study has been observed previously in several earlier Antarctic studies^{11,13,14,21} and by Miller¹⁵ in Diego Garcia, where the climatological factors were entirely different, but the isolation and research protocol were very similar. During the early and middle periods of deployment, group isolation seems to magnify introspection, producing an attitude of personal concern for self-improvement while removed from social factors which normally counter such efforts. During wintering-

over periods, personal goals varied over a broad spectrum and included among others such endeavors as weight reduction and college credit accumulation. Acceptance of the extended state of isolation, coupled with a mood of personal resolve, could only enhance motivational attempts at improving oral hygiene. Regressive phenomena repeatedly seem to coincide with impending re-integration into social patterns established prior to the isolated deployments.

Although exposure to a monthly dental examination and living in close proximity to one's personal dentist may have been a primary motivating factor in stimulating the high degree of improved oral health, the regressions observed at the end of the wintering-over period make it apparent that all efforts at motivation were at least temporarily compromised during periods of occupational stress. The use of a double-blind procedure was not possible because of professional staffing limitations. Investigator credibility is supported, however, by the findings which are consistent with earlier studies^{11,13,14,15} which suggest that frequent examinations and participation in a study provide only transitory behavioral changes. It appears that some form of improved motivational input is essential if high levels of oral hygiene and gingival health are to be maintained.

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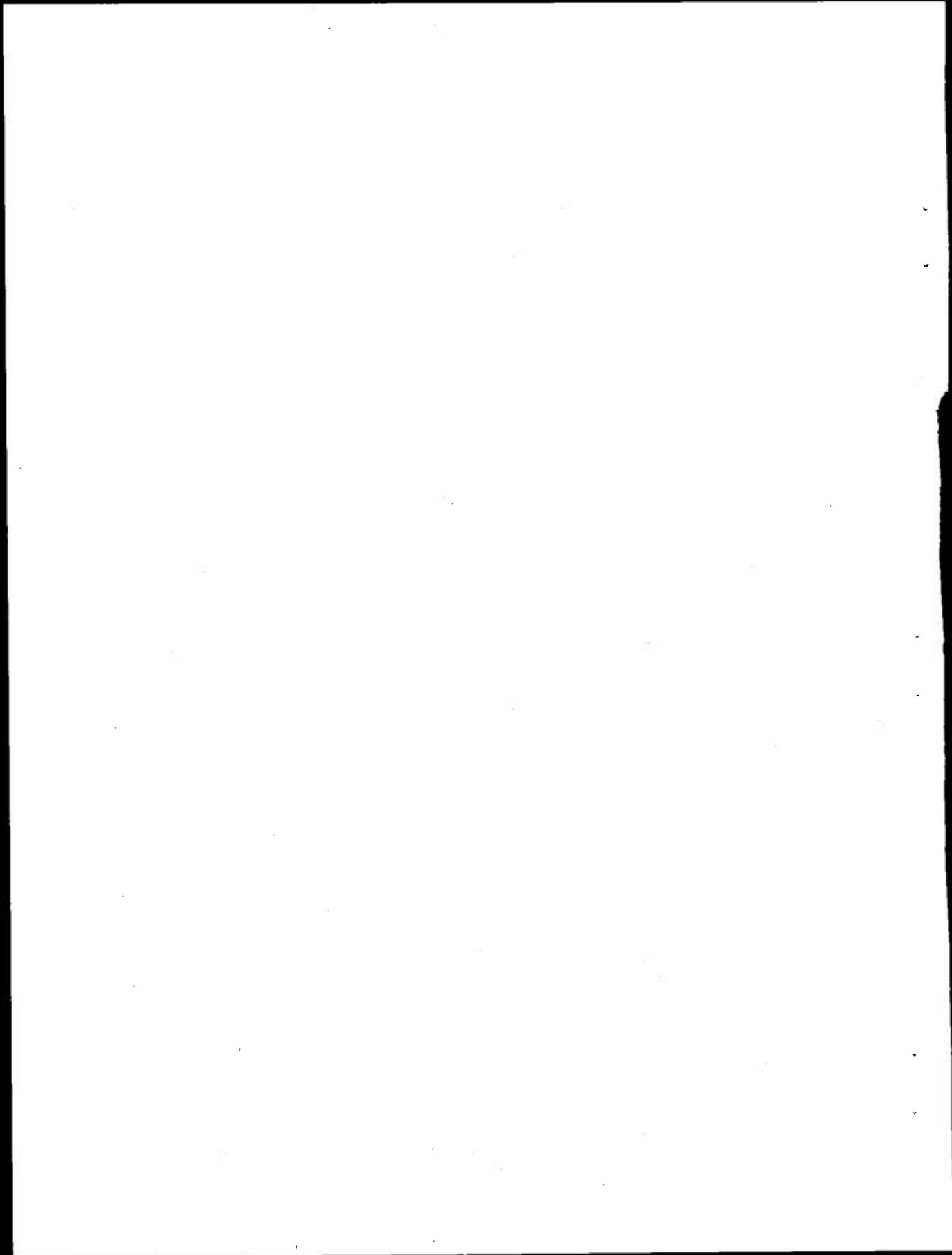
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