A Method for Evaluating Oral Hygiene Performance

ARLON G. PODSHADLEY, D.D.S., M.S.D., and JOHN V. HALEY, Ph.D.

RECENT INVESTIGATIONS have demonstrated that there is a strong positive correlation between poor oral hygiene and periodontal disease (1–9). An awareness of this relationship has stimulated dentists to place greater emphasis on teaching patients the importance of good oral hygiene and the best methods for obtaining it. It has also stimulated additional study of the role of oral debris in dental disease. The current emphasis on patient education and on research in oral hygiene has underlined the need for a simple and accurate method for measuring the oral hygiene of dental patients.

The simplified oral hygiene index (OHI-S) developed by Greene and Vermillion for measuring oral hygiene (10) has proved a reliable instrument for large epidemiologic studies. The need, however, for a simpler and more sensitive measurement device both for research and for use by the dental practitioner has stimulated the development of the patient hygiene performance (PHP) method (11, 12).

This paper reports the results of an investigation comparing the Podshadley PHP method with the well-established debris index—simplified (DI-S) aspect of the Greene and Vermillion OHI-S method.

Determining the PHP Score

A mouth mirror examination of selected teeth is made after the patient has been given an erythrosin disclosing wafer which stains the oral debris a dark pink. Oral debris is defined as the soft foreign material consisting of mucin, bacteria, and food that is loosely attached to the tooth surface. The patient is instructed to chew the disclosing wafer and to "swish" for 30 seconds. He may then expectorate but is not permitted to rinse his mouth until after the examination.

The examination is performed on the following teeth in this order: (a) maxillary right first molar, (b) maxillary right central incisor, (c) maxillary left first molar, (d) mandibular left first molar, (e) mandibular left central incisor, (f) mandibular right first molar. The tooth surfaces which are assessed are the buccal of the maxillary molars, the lingual of the mandibular molars, and the labial of the maxillary and mandibular incisors.

If the first molars are missing, are less than three-fourths erupted, have full-crown restorations, or are too badly broken down to assess, the second molar is substituted. If the second molar is missing or cannot be used, the third

molar is then substituted. If all three molars are missing or cannot be used, an M is placed on the recording chart.

If the designated central incisor is missing or cannot be used, the adjacent central incisor is substituted. If both central incisors are missing or cannot be used, again an M is placed on the chart.

To assess the debris on each surface, the examiner must mentally divide the tooth into five sections (fig. 1). The clinical crown is subdivided longitudinally into mesial, middle, and distal thirds. The mesial and distal thirds make up the first two subdivisions; each area extends to the middle third of its adjacent proximal surface. The remaining middle third is then subdivided horizontally into the gingival, middle, and occlusal thirds.

Each of the subdivisions is examined for the presence of the pink-stained oral debris. If no debris is present, 0 is assigned to that section; if debris is present, 1 is assigned. The value of 1 is assigned only to those areas on which debris is definitely present. The lesser score of 0 is assigned to all questionable areas.

The debris score for each tooth is determined by adding the values of each of the five subdivisions. For example, in figure 1–B, debris is present in both proximal areas and in the gingival third; the debris score is 3. In figure 1–C, debris is present in one proximal area only; the debris score is 1. In figure 1–D, debris is present in both proximal areas, the gingival third, and the middle third; the debris score is 4.

The debris score for the designated surface of each of the six teeth is entered in a table, and the patient hygiene performance score is then calculated by dividing the sum of the scores by the number of surfaces charted as shown in the following examples.

	Debris score	
	Example 1	Example 2
Tooth surface		
Maxillary right molar____	3	4
Maxillary right central incisor_____	2	2
Maxillary left molar_____	4	5
Mandibular left molar____	3	3
Mandibular left central incisor_____	1S	1
Mandibular right molar___	3	M
Sum of scores_____	16	15

$$\text{PHP}\left(\frac{\substack{\text{sum of debris}\\\text{scores}}}{\substack{\text{number of}\\\text{debris scores}}}\right)\text{----}\qquad \frac{16}{6},\text{ or }2.66 \qquad \frac{15}{5},\text{ or }3.0$$

In example 1, the letter S indicates that a substitute tooth was used. In example 2, M indicates a missing score and that tooth is therefore not included in the computation. For that reason the number of debris scores equals 5 instead of 6.

Survey Methods

Fifty-five sixth-grade children aged 11 to 12 were examined independently by two examiners. Each examiner performed three examinations on each child. First a DI-S score was calculated on the same child by each examiner. After both examiners had completed the DI-S, the child was asked to chew an erythrosin dye tablet and swish saliva around all of the teeth. Each examiner then calculated a patient hygiene per-
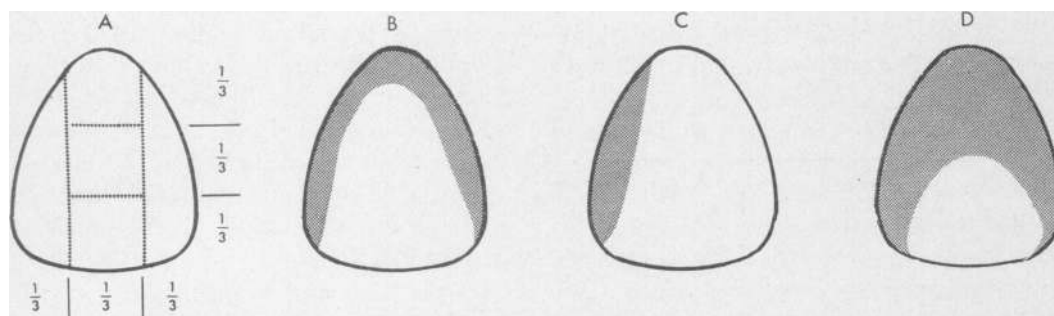

Figure 1. The subdivisions of a tooth used in PHP (patient hygiene performance) method, with examples of scoring by this method: A. Five subdivisions, B. debris score of 3, C. debris score of 1, and D. debris score of 4

Table 1. Interexaminer comparisons for the DI–S method and for the PHP method with dye tablet and with liquid dye

Method	Number of children examined	Mean score		Standard deviation		Difference between mean scores		Correlation coefficient (examiner 1 to examiner 2)
		Examiner 1	Examiner 2	Examiner 1	Examiner 2	t scores	Probability [1]	
DI–S_____	55	1.435	1.359	±0.335	±0.447	1.82	0.074	0.72
PHP with dye tablet—first examination_____	55	3.367	3.391	±.638	±.547	.531	.597	.85
PHP with dye tablet—second examination_____	55	3.337	3.365	±.612	±.599	.692	.492	.87
PHP with liquid dye_____	55	3.559	3.592	±.560	±.528	1.06	.291	[2].91

[1] No significant difference between mean scores at the 0.05 level of confidence in any comparison.

[2] The correlation coefficient of 0.91 for the PHP method when liquid dye was used was significantly higher than the correlation coefficient of 0.72 for the DI–S method ($P = <0.001$).

formance score for the child. The child was then returned to his classroom but instructed not to brush his teeth, eat, or in any way disturb the stain on the teeth. He was returned to the examination room 1 hour later and again asked to chew and swish another dye tablet. The PHP score was again calculated by each examiner.

We conducted the examination in the school auditorium, using portable dental chairs and lights. To assure completely independent scoring, the dental chairs were placed so that the examiners could not overhear each other. The examiners in this investigation had been trained in the DI–S techniques, and each examiner had had previous experience in using both methods. Since the DI-S method requires the use of an explorer to detect debris, the examiners took special precautions to avoid any unnecessary disturbance of the debris when using this method.

We had some minor difficulty in getting the debris in all of the children's mouths to stain uniformly well with the dye tablet; occasionally a child had to repeat the staining procedure before an accurate PHP score could be calculated. For this reason, we calculated the patient hygiene performance score again on another group, using liquid dye instead of the dye tablet. This group also numbered 55 sixth-grade children aged 11 to 12; all were from the same school as those on whom the dye tablet had been used. In this part of the investigation, each child was instructed to swish the erythrosin solution (4 drops of a 6 percent aqueous solution of ery-

throsin in 6 cc. of water) around all of his teeth for approximately 15 seconds. The DI-S was not calculated, and the children were not reexamined after 1 hour. Except for these differences, this examination was conducted in the same manner as when the dye tablet was used.

Analysis of Data

Pearson's product moment correlation coefficients were used to determine the interexaminer and intraexaminer relationships. The interexaminer correlations were considerably higher with the PHP method than with DI–S (table 1). This result indicates a greater consistency between examiners using the PHP method than between those using the DI–S. Although the correlations were quite high when the dye tablet was used, the interexaminer correlation improved when the liquid dye was substituted.

A test for significance using Fisher's Z transformation was applied to the difference between the interexaminer correlation coefficient of 0.91 for the PHP with liquid dye and the 0.72 for the DI-S. This difference was found to be highly significant; the probability that it could have occurred by chance was less than 1 in 1,000. The PHP method with liquid dye was tested at a different time and with a different group of children, but in the same school on the same age group. For this reason we believe that the results can be directly compared with the

interexaminer correlation obtained for the DI-S examinations. The same test for significance was applied to the difference between the interexaminer correlations of 0.72 for the DI-S and 0.85 for the PHP with dye tablets. Although this difference was not significant at the 0.05 level of confidence, it approached significance; the probability that it could have occurred by chance was only 8 in 100.

The intraexaminer correlation coefficients between the first and second PHP examinations were 0.85 for the first examiner and 0.80 for the second (table 2). These high correlations demonstrate that an examiner can repeatedly use the PHP score with a high degree of accuracy. The intraexaminer correlations were slightly lower than the interexaminer. This result is probably explained by the hour between the first and second examinations, a period in which the children were returned to their classroom and were not directly supervised by the investigators. Although the children were asked not to eat or to otherwise disturb their teeth in any way, this advice was probably not followed precisely. The investigation with liquid dye was not designed to provide intraexaminer comparisons.

The consistently high correlations achieved with the PHP method demonstrate that the examiners were able to make the necessary judgments consistently. This ability could have resulted from the division of the tooth into five parts, the use of dye, or a combination of the two procedures. Making the debris visible with the dye was probably the most important factor. It is important to note, however, that the high correlations demonstrate that examiners had no difficulty in making the increased number of

judgments required in the PHP method. This ease is important because the increased number of subdivisions in the PHP method places more emphasis on the proximal and gingival areas—the most important areas in peridontal disease etiology.

The significance of the difference between the means of the scores recorded by examiner 1 and examiner 2 in each group was determined by the t test for correlated measures. The t scores and probabilities are tabulated in table 1. The difference between the means was not significant at the 0.05 level of confidence in any comparison. Although the difference between the means of the scores of the two examiners was not significant in either the DI–S or the PHP method, the difference between the means with the DI–S method approaches a point of significance, the probability that this difference could have occurred by chance being 7 in 100.

The t test for significance was also applied to the difference between the means of the scores obtained by each examiner on the first and second PHP examination (table 2). Again the difference was not significant for either of the examiners at the 0.05 level of confidence.

The standard deviations are somewhat higher with the PHP than with the DI–S method (table 1). The very high interexaminer and intraexaminer correlations achieved with the PHP method indicate that these higher values are probably the result of the different possible range of scores for the two methods—0–3 for the DI–S and 0–5 for the PHP.

The raw DI–S scores were separated into the ranges of 0–1.0, 1.01–2.0, and 2.01–3.0, and the means of the scores listed in each range were calculated, along with the means of the compa-

Table 2. Intraexaminer comparisons of mean scores for first and second examinations by PHP method with dye tablet

Examiner	Number of children examined	Mean scores		Difference between mean scores		Correlation coefficient (first examination to second)
		PHP with dye tablet—first examination	PHP with dye tablet—second examination	t scores	Probability [1]	
1	55	3.367	3.337	0.646	0.521	0.85
2	55	3.391	3.365	.532	.597	.80

[1] No significant difference between mean scores at the 0.05 level of confidence for either examiner.

Figure 2. Means of DI-S (debris index—simplified) scores and of the comparable PHP (patient hygiene performance) scores for 55 sixth-grade school children 11 to 12 years old
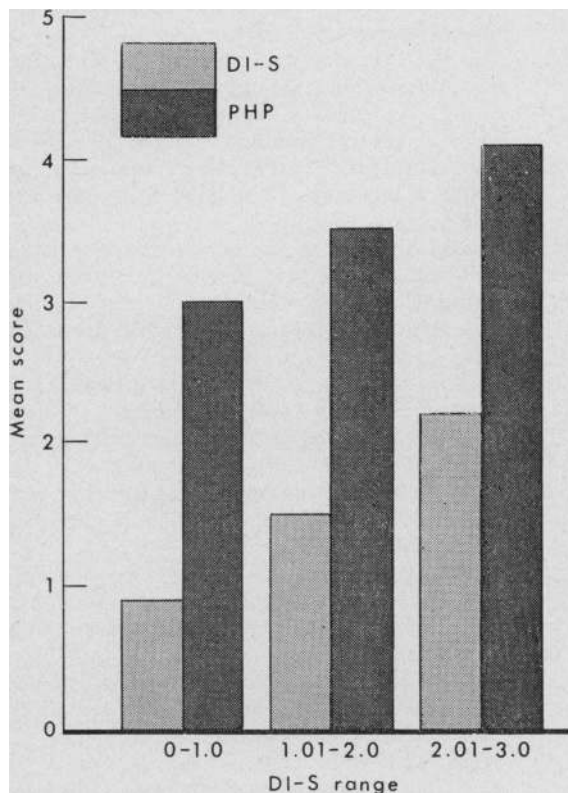
rable PHP scores for children in each group. These mean scores are illustrated graphically in figure 2. The mean PHP scores, although higher in each range, parallel the mean DI–S scores.

Discussion

Dentists and dental health educators have often taught dental health concepts without following the basic educational structure which has proved effective for the classroom teacher. This structure includes (a) determination of precisely what is to be taught (preparing objectives), (b) design of the necessary learning experiences to fulfill these objectives, (c) design of a method for determining to what extent the objectives have been fulfilled (evaluation), and (d) reinstruction based on results of the evaluation. To be sure, dentists and dental health educators have used the first two steps of this educational structure, but seldom the

third and fourth steps of evaluation and reinstruction.

The high intraexaminer correlations obtained with the PHP method suggest that the effectiveness of oral hygiene instruction can be evaluated with reasonable accuracy by this measurement. An important advantage of the PHP method for this purpose is its ability to detect changes in the critical proximal and gingival areas. Moreover, since current toothbrushing instruction includes use of the dye tablet, the preinstruction calculation of a PHP score and the subsequent periodic recalculation require little additional time for the dentist-teacher.

The interexaminer correlations of 0.85 and 0.87 for the PHP method with the dye tablet are sufficiently high to justify its use for research investigations. However, since the interexaminer correlation for the PHP method with liquid dye was even higher and the difference between this 0.91 correlation and the 0.72 correlation for the DI-S proved to be significant, we suggest using the liquid dye for research whenever possible. When the liquid dye was used, none of the children's teeth required restaining, and both examiners were better satisfied with the more uniform and positive staining.

The PHP method was originally developed to provide dental students at the University of Kentucky with an instrument for assessing the effectiveness of the patient's education in oral hygiene (11, 12). In the method's original form, the premolars were examined rather than the molars because the premolars were considered somewhat easier for dental students to assess visually. In our investigation, however, we modified the original method in order to examine the same teeth that Greene and Vermillion assessed in the OHI-S method (10). This modification made possible a more accurate comparison with the DI-S method. Also, the tooth surfaces examined were those which Greene and Vermillion have shown to be representative of all tooth surfaces (10).

In our investigation, the PHP survey was somewhat more complicated to conduct than the DI-S because an additional person was required to administer the dye. Nevertheless, the PHP method definitely saved time. Participants in the investigation estimated that the

PHP examinations were conducted in one-half of the time required for the DI-S. Moreover, both examiners considered the visual examinations in the PHP method considerably easier to accomplish than the DI-S examinations.

Although the interexaminer correlation of 0.72 for the DI-S method is sufficiently high for use in a large epidemiologic study, the higher correlations obtained with the PHP method suggest that it is a more sensitive measure and can serve a useful purpose in dental health education and research.

Summary and Conclusions

The PHP (patient hygiene performance) method for assessing oral debris was compared with the DI-S (debris index—simplified) aspect of the Greene and Vermillion OHI-S (oral hygiene index—simplified). In the PHP method, erythrosin dye is used to stain the debris, and the tooth surface is subdivided into five sections, each of which is assessed for the presence of debris.

Two examiners calculated the DI-S and PHP scores for 55 children 11 to 12 years old. The investigation was structured to determine the interexaminer relationship for the DI-S scores and the interexaminer and intraexaminer relationship for the PHP scores when the teeth were stained with a dye tablet. In addition, the interexaminer relationship was determined for the PHP method when liquid dye was substituted for the dye tablet.

The results of all methods were subjected to statistical analysis, and the following conclusions were drawn:

1. The examiners' results were more consistently alike when they used the PHP method than when they used the DI-S method.

2. Each examiner was able to repeat the PHP examination with a high degree of consistency.

3. The PHP method is sufficiently sensitive to justify its use in dental health education and research.

REFERENCES

(1) Greene, J. C.: Periodontal disease in India: report of an epidemiological study. J Dent Res 39: 302–312, March–April 1960.

(2) Greene, J. C.: Oral hygiene and periodontal disease. Amer J Public Health 53: 6, June 1963.

(3) Lovdal, A., Arno, A., and Waerhaug, I.: Incidence of clinical manifestations of periodontal disease in light of oral hygiene and calculus formation. J Amer Dent Assoc 56: 21–33, January 1958.

(4) Lovdal, A., Arno, A., Schei, O., and Waerhaug, I.: Combined effect of subgingival scaling and controlled oral hygiene on the incidence of gingivitis. Acta Odont Scand 19: 537–555, December 1961.

(5) Lovdal, A., Schei, O., Waerhaug, I., and Arno, A.: Tooth mobility and alveolar bone resorbtion as a function of occlusal stress and oral hygiene. Acta Odont Scand 17: 61–77, May 1959.

(6) Ramfjord, S. P.: The periodontal status of boys 11 to 17 years old in Bombay, India. J Periodont 32: 237–248, July 1961.

(7) Russell, A. L., and Ayers, P.: Periodontal disease and socioeconomic status in Birmingham, Alabama. Amer J Public Health 50: 206–214, February 1960.

(8) Russell, A. L.: A system of classification and scoring for prevalence surveys of periodontal disease. J Dent Res 35: 350–359, June 1956.

(9) Schei, O., Waerhaug, J., Lovdal, A., and Arno, A.: Alveolar bone loss as related to oral hygiene and age. J Periodont 30: 7–16, January 1959.

(10) Greene, J. C., and Vermillion, J. R.: The simplified oral hygiene index. J Amer Dent Assoc 68: 7–13, January 1964.

(11) Podshadley, A. G.: Preventive dentistry clinical procedures. University of Kentucky, Lexington, 1966. Mimeographed.

(12) Podshadley, A .G.: The implementation of basic educational concepts in a preventive dentistry teaching program. Proceedings of Workshop on the Teaching of Preventive Dentistry and Community Health. University of Kentucky, Lexington, 1967.

ROMANI, JOHN H. (School of Public Health, University of Michigan): *How public health administrators perceive their constituencies. Public Health Reports, Vol. 83, March 1968, pp. 239–244.*

Interviews with 29 health administrators from two State health departments and one Provincial (Canadian) health department in 1964–65 revealed varying perceptions of the relationship of the administrator's organization to the public which that organization served. The administrators had widely differing administrative responsibilities but were considered by their respective organizations as the top management of their units.

Sixteen of the 29 respondents suggested that their department's concerns focused on the public at large. Three of the 13 other respondents indicated that their department's activities primarily affected the clientele it served, and 10 held that the health professionals were the persons most directly affected by their department's work.

Both the variations and similarities in perceptions may possibly be explained by differences in the career patterns of the administrators and in the formally defined relationships between their agencies and the chief executive of the State or Province. These propositions, however, could not be tested fully with the data available. Such testing must await more extensive study in which various factors, such as level of government, type of function, and political setting, are held constant.

FOX, RUTH I. (Westchester County Department of Health), **GOLDMAN, JACK J.,** and **BRUMFIELD, WILLIAM A., Jr.:** *Determining the target population for prenatal and postnatal care. Public Health Reports, Vol. 83, March 1968, pp. 249–257.*

Based upon health priority reasons or socioeconomic criteria, or both, 555 mothers and their newborn infants were selected and referred to public health nurses for interviews and for evaluation by physicians and nurses for admission to the Westchester County Health Department's program of post partum followup care and supervision.

The survey results indicated that among this high-risk group of families 17 mothers or 3 percent received no prenatal care at all, 134 women or 24 percent did not get early prenatal care, and frequency of prenatal visits averaged two a month per mother only during the eighth and ninth month of pregnancy.

The mothers' lack of recognition of the importance of early care combined with denial of pregnancy, no one to care for the other children, and transportation difficulties were the four chief reasons accounting for late prenatal care.

This study pointed out that socioeconomic factors were as important as health reasons in selecting the target population for prenatal and postnatal care. The number of mothers and infants who needed and obtained the department's post partum followup care and supervision was doubled when families were chosen from the lower social class in addition to identification for health considerations alone.

PODSHADLEY, ARLON G. (University of Kentucky Medical Center), and **HALEY, JOHN V.:** *A method for evaluating oral hygiene performance. Public Health Reports, Vol. 83, March 1968, pp. 259–264.*

The PHP (patient hygiene performance) method for assessing oral debris was compared with the DI-S (debris index—simplified) aspect of the Greene and Vermillion OHI-S (oral hygiene index—simplified). In the PHP method, erythrosin dye is used to stain the debris, and the tooth surface is subdivided into five sections, each of which is assessed for the presence of debris.

Two examiners calculated the DI-S and PHP scores for 55 children 11 to 12 years old. The investigation was structured to determine the interexaminer relationship for the DI-S scores and the interexaminer and intraexaminer relationship for the PHP scores when the teeth were stained with a dye tablet. In addition, the interexaminer relationship was determined for the PHP method when liquid dye was substituted for the dye tablet.

The results of all methods were subjected to statistical analysis, and the following conclusions were drawn.

1. The examiners' results were more consistently alike when they used the PHP method than when they used the DI-S method.

2. Each examiner was able to repeat the PHP examination with a high degree of consistency.

3. The PHP method is sufficiently sensitive to justify its use in dental health education and research.