A RAND NOTE

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Improve Oral Health?**

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April 1987

RAND

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**Prepared for
The U.S. Department of Health and Human Services**

RAND

This first large-scale, randomized controlled study helps answer a question with major health policy implications:

Does more generous dental insurance coverage improve oral health?

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Today, almost 100 million Americans have dental insurance.¹ This represents a dramatic increase in coverage in the past 15 years; it has led to the use of more services as well as a more expensive mix of services for those who visit the dentist.²

Although it can be reasonably assumed that greater use of dental services by patients who have insurance improves oral health, this basic association has yet to be demonstrated. Indeed, the few studies that have addressed the issue have found no significant differences in oral health between the insured and the uninsured.³⁻⁵ No definitive conclusions can be reached, however, because of various problems in the designs of those studies.

The impact of dental insurance on oral health has major health policy implications. Both public and private purchasers of group insurance justify greater expenditures for dental care in terms of improved oral health. If there is little or no relationship between the two, current government policies that finance dental programs for the underserved and provide an indirect tax subsidy for private dental insurance are likely to receive

serious challenge. Employers and unions may also conclude that dental coverage is not worth the cost.

The Rand Health Insurance Experiment (HIE) was undertaken to address this and other issues. An earlier paper gave a more detailed description of the study's objectives and rationale.⁶ In a subsequent paper, data on utilization and expenditures are presented.⁷

In this report, we consider the relationship between dental insurance and oral health by examining the effects of different levels and types of cost sharing (coinsurance, deductibles) on oral health. We also investigate the effects of cost sharing on the oral health of different subgroups of the population. We are particularly interested in knowing how cost sharing influences the oral health of the disadvantaged.

Methods

Sample

The analysis included 4,815 dentate people, between ages 6 and 61 years at the time of enrollment into the HIE, who received an exit oral examination. Two-thirds of the sample participated in the study for 3 years, the remainder for 5 years.

The study ran in six geographic sites (Dayton, OH; Seattle, WA; Fitchburg and Franklin County, MA; and Charleston and Georgetown County, SC) between 1974 and 1982. Families were selected at random; households with incomes above \$58,200 (1984 dollars) and family members older than 61 at enrollment were excluded from the study. Each family was placed by a variant of stratified random assignment into one of several experimental insurance plans.⁸

Insurance plans

The insurance plans covered a broad range of medical and dental benefits including all dental services other than orthodontic treatment with fixed appliances. Families obtained care from the practitioners of their choice.

Most plans had the same coinsurance rate for all care (medical and dental): either 0% (free care), 25%, 50%, or 95%. In the plans that required some cost sharing, the family's annual out-of-pocket liability (maximum dollar expenditure) was limited to 5%, 10%, or 15% of its income, or \$1,000, whichever was less. Three plans differed from this scheme. One plan had a 25% coinsurance rate on medical expenses but 50% on dental and outpatient mental health services; in the analysis, enrollees in this plan are included in the 50% group. A second plan, the individual deductible, attached a 95% coinsurance rate to outpatient services but provided free inpatient care. The maximum dollar expenditure for this group was \$150 per individual, to a maximum of \$450 per family. Finally, in Seattle, one group of subjects was randomly assigned to a health maintenance organization (HMO) (Group Health Cooperation) for its medical care. Because the HMO did not provide dental ser-

Table 1 ■ Sociodemographic characteristics and oral health status* at enrollment to the study, by type of insurance plan.

Variable	Cost-sharing plans				ID	Significance level
	Free	25%	50%	95%		
Mean age (yr)	24.8	25.2	24.8	24.6	25.8	NS†
Gender (% female)	52	50	53	52	53	NS
Mean family income (1984 \$ in thousands)	20.8	25.9	23.3	23.3	23.3	NS
Mean education (yr)	11.8	12.3	12.1	12.0	11.9	NS
Race (% white)	80	79	84	77	79	NS
Mean no. decayed teeth	2.2	2.1	2.2	2.2	2.3	NS
Mean no. filled teeth	6.3	6.6	6.5	6.6	6.3	NS
Mean no. missing teeth	3.2	3.3	3.5	3.2	3.3	NS
Mean no. DMF teeth	11.7	12.0	12.3	12.0	11.9	NS
Mean periodontal index	1.3	1.3	1.3	1.4	1.3	NS

*All analyses exclude third molars.

†Not significant, $P < .05$.

Table 2 ■ Mean number of decayed teeth* at exit from the study by plan and age group.

Cost-sharing plan	Age group			
	6 to 11 n = (840)	12 to 17 (744)	18 to 34 (1,794)	35 to 64 (1,437)
Free	1.2	1.6	1.3	1.6
25%	1.3	1.7	1.7	1.6
50%	1.9†	2.3	1.5	1.5
95%	1.6†	3.2†	2.0†	1.8
Individual deductible	1.5	2.6†	1.9†	1.6
All cost-sharing plans	1.6†	2.5†	1.8†	1.6

*Values shown are adjusted as described in data analysis section.

† $P < .01$, one-tailed test.

Hypotheses tests compare the free with cost-sharing plans.

Table 3 ■ Mean number of filled teeth* at exit from the study, by plan and age group.

Cost-sharing plan	Age group			
	6 to 11 n = (840)	12 to 17 (744)	18 to 34 (1,794)	35 to 64 (1,437)
Free	3.5	7.9	12.0	10.3
25%	3.3	6.1†	10.7†	9.3
50%	2.3†	7.0	11.0†	9.7
95%	2.7†	6.4†	10.2†	8.8†
Individual deductible	2.7†	7.1	10.6†	8.9†
All cost-sharing plans	2.7†	6.7†	10.5†	9.1

*Values shown are adjusted as described in data analyses section.

† $P < .01$, one-tailed test.

Hypotheses tests compare the free with the cost-sharing plans.

vices, enrollees received free dental care from fee-for-service dentists of their choice. As such, we included them with the other free plan enrollees in our analysis.

The influence of cost-sharing plans on oral health status does not depend on coinsurance effects alone. Enrollees who met the maximum dollar expenditure were eligible for free dental care (for the remainder of the year) and, the higher the coinsurance rate, the greater the likelihood of exceeding the annual liability. Thus, the analysis compares the effects of entire benefit packages on oral health status, not just the specific effects of different coinsurance rates.

Clinical measures of oral health

Dental examinations were performed on all subjects at the end of the study and on a ran-

Purchasers of group dental insurance justify greater expenditures for dental care in terms of improved oral health.

The insurance plans covered a broad range of medical and dental benefits including all dental services other than orthodontic treatment with fixed appliances.

domly selected 60% at the beginning. For the 40% who were not examined at enrollment we imputed entrance oral health scores based on known relationships among sociodemographic variables and oral health measures.

Trained dental examiners used standard examination methods to evaluate the number of decayed, missing, and filled permanent teeth (DMFT) or decayed, extracted, and filled primary teeth (deft).⁹ For participants older than 11 years, we used Russell's periodontal index to assess periodontal disease.¹⁰ This index is based on a scale of five scores (0, 1, 2, 6, and 8); higher scores indicate more severe disease.

To measure intraexaminer reliability, 2% of the sample at enrollment was reexamined by the same dentist about 30 minutes after the first examination. Correlations between the first and second DMFT or deft scores all exceeded 0.95. No data were available on intraexaminer reliability measuring periodontal disease. To allow for possible differences between examiners in scoring oral health, we included a variable for each examiner in the regression analyses, if an examiner effect was found.

Data analysis

Because the prevalence and incidence of caries and periodontal disease vary by age, we divided the sample into four age groups for separate analysis: 6 to 11, 12 to 17, 18 to 34, and 35 to 64 years. Periodontal data were not collected for children younger than 12; hence, the periodontal analysis includes only three age groups.

We used regression analysis to estimate the effects of plan and other explanatory variables on oral health. Each dental health outcome measured at exit (numbers of decayed; missing; filled; and DMFT28 teeth, based on 28 teeth, third molars excluded; and the periodontal index) was assessed separately. For the DMFT28

analysis, subjects with a DMFT28 score of 28 at enrollment were excluded, because their scores could not change during the study period. For the periodontal analysis, the periodontal index scores were recorded so that 6 and 8 became 3 and 4, respectively, to reduce

cluded only if they contributed significantly ($P \leq .05$) to the prediction of oral health at exit from the study.

Although the main goal of this analysis was to determine the effects of cost sharing on oral health status, including other explanatory variables served three purposes. They helped control for any minor imbalance in enrollees across plans. Because these other variables explained an important part of the variation in the oral health outcomes, the measurement of insurance plan effects also was made more precise. In addition, some of the other variables (for example, education), as well as interactions, were themselves of interest.

Because people with more disease also showed more variability in their disease rates, we used the method of weighted least squares instead of ordinary least squares regression, to obtain more efficient and stable estimates. Furthermore, because all members of a family were enrolled in the HIE, all analyses were corrected for intrafamily correlations.

To make the results more interpretable clinically, we predicted the mean oral health outcome scores for the hypothetical "average" person in each plan and age group. For the same reason, we predicted scores for the "average" person on all the cost-sharing plans together. This allows us to compare the effects of no versus some cost sharing.

To assess the differential effects of cost sharing on subgroups of the population, we also predicted mean scores for subjects with high, average, and low education and enrollment oral health scores. The definition of "high" and "low" cut-offs was 1 standard deviation above or below a variable's mean. For each set

the undue influence of extreme scores and thereby improve the fit of the regression model.

We used the following variables to explain oral health outcomes: experimental insurance plans; geographic site; individual's corresponding oral health score at enrollment; number of years of education: for adults, the person's own education; for children (younger than 18 years of age), the education of the female head of household, and, if unavailable, the education of the male head of household; age and gender; pre-enrollment family income and family size; length of time enrolled in the experiment; data quality variables; examiner variables; and interactions between plans and education, and enrollment oral health status. The latter two groups of variables were in-

Table 4 ■ Mean number of missing teeth* at exit from the study, by plan and age group.

Cost-sharing plan	Age group			
	6 to 11 n = (840)	12 to 17 (744)	18 to 34 (1,794)	35 to 64 (1,437)
Free	.5	1.0	3.2	8.3
25%	.4	.8	3.3	7.8
50%	.7	1.2	2.9	8.0
95%	.5	1.3	3.2	8.5
Individual deductible	.4	1.1	3.3	8.5
All cost-sharing plans	.5	1.1	3.2	8.2

*Values shown are adjusted as described in data analyses section. Hypotheses tests compare the free with the cost-sharing plans.

Table 5 ■ Mean number of DMFT28 teeth* at exit from the study, by plan and age group.

Cost-sharing plan	Age group			
	6-11 n = (840)	12-17 (744)	18-34 (1,794)	35-64 (1,437)
Free	5.3	10.6	16.1	19.4
25%	5.1	8.9†	15.9	18.5
50%	5.3	10.8	15.6	19.2
95%	5.2	11.1	15.3†	19.1
Individual deductible	4.6	10.9	15.7	19.3
All cost-sharing plans	5.1	10.6	15.6	19.0

*Values shown are adjusted as described in data analyses section.

†P < .01, one-tailed test.

Hypotheses tests compare the free with the cost-sharing plans.

Table 6 ■ Mean scores for the periodontal index* by plan and age group at exit from the study.

Cost-sharing plan	Age group		
	12 to 17 n = (734)	18 to 34 (1,759)	35 to 64 (1,293)
Free	.84	.96	1.12
25%	.94†	1.08†	1.17
50%	.98†	1.04	1.17
95%	.95	.99	1.12
Individual deductible	1.01†	1.01	1.21
All cost-sharing plans	.96†	1.02	1.16

*Values shown are adjusted as described in data analyses section. PI scores were rescaled from 0, 1, 2, 6, and 8 to 0, 1, 2, 3, and 4; lower scores indicate better periodontal health.

†P < .01, one-tailed test.

Hypotheses tests compare the free with the cost-sharing plans.

of predicted oral health values, we tested the difference between the free and all the cost-sharing plans combined.

We did not include family income in the subgroup analysis. Although it is an important policy relevant variable, family income was not associated significantly with changes in enrollee oral health status during the course of the HIE and did not interact with the plans.

Because better financial access to dental care should improve oral health (for example, subjects in the free plan are expected to have fewer decayed teeth), we used a one-tailed test of significance. In the analysis of subgroup differ-

ences among plans, the direction of effects was not apparent a priori, and two-tailed tests of significance were used. With multiple comparisons, some might be significant from chance alone. Consequently, we present only those results that are significant at the .01 level.

■ Results

Threats to validity

ACCEPTANCE OF ENROLLMENT OFFER. Of the

families initially approached, 15% refused a screening or baseline interview and 20% did not take a subsequent pre-enrollment interview. None of these families was told the specific details of the experiment. Of those offered an opportunity to enroll, 15% declined; refusals varied from 8% of families in the free plan to 25% in the 95% plan. To determine whether these different acceptance rates may have biased the results, we examined the sociodemographic and oral health status of enrollees at the start of the experiment and adjusting for site differences, found no significant differences among plans for any variable (Table 1).

LOSS OF SUBJECTS IN EXPERIMENT. Some people dropped out during the 3 to 5 years of the project. In all, 95% of enrollees in the free plan completed the study as did 85% to 90% of those in the different pay plans. To test whether differential attrition biased the final results, we investigated the oral health status at enrollment of those leaving and remaining in the study. We found no significant difference for any oral health measure. Thus, differential attrition rates were unlikely to have influenced the study findings.

Effects of plans on oral health status

DECAYED, MISSING, AND FILLED TEETH. At exit from the study, persons in the free plan had fewer decayed teeth than did those in the pay plans, and except for the 35- to 64-year-old group, most differences were statistically significant (Table 2). Subjects in the least generous plans (95% and individual deductible) usually had the highest prevalence of decay.

The magnitude of the differences between the free and cost-sharing plans varied by age group. The largest difference was among the 12- to 17-year-old group; subjects in the free plan had 1.4 fewer decayed teeth than those in the 95 percent plan. This represents 82% less decay for those in the free plan. In the 35- to 64-year-old group, the difference between the two plans was less than 0.3 teeth.

The results for filled teeth by plan were generally the opposite of the decay findings. For all comparisons, individuals on the free plan had more filled teeth at the end of the experiment (Table 3).

We observed no significant plan differences for missing teeth (Table 4). However, children, aged 12 to 17, on the 50% and 95% plans tended to have more missing teeth than did those on the free plan ($P \leq .05$).

The DMFT28 index was significantly reduced in the 25% and 95% plans for two age groups (Table 5). The reduction resulted primarily from having relatively fewer filled teeth in the pay plans compared with the free plan.

The positive association between plan generosity and oral health may have been even greater with an uninsured cohort in the study.

PERIODONTAL DISEASE. For all age groups, persons in the free plan tended to have lower periodontal index scores (better periodontal health) than subjects in any pay plans (Table 6). The largest effect was seen in the adolescent age group; there, most of the free versus pay plan comparisons were significant.

To summarize the findings for DMF teeth and periodontal disease, Table 7 compares the free and the combined cost-sharing plans and lists the plan showing a significant positive effect on oral health. The free plan is associated with better outcomes for the number of decayed and filled teeth and periodontal disease, especially for children. No significant plan differences are seen for missing and DMF teeth.

Subgroup analysis

DECAYED, MISSING, AND FILLED TEETH

Persons in the free plan had fewer decayed and more filled teeth, fewer missing teeth, and less periodontal disease.

Education. Children and teenagers from families with average and low education (fewer years of schooling) who were on the free plan showed significantly better oral health outcomes (number of decayed, filled, and missing [teenagers only] teeth). There were no significant plan and education associations for the other age groups or for the DMFT index (Table 8). (Because of the amount and complexity of the results, Tables 8 through 10 do not provide the actual oral health outcome values for each subgroup and plan. These will be available in a Rand Report on the HIE dental findings.)

Enrollment oral health. In the three younger cohorts, only free plan subjects with average or high levels of decay at enrollment had significantly less decay at exit from the study. For the two middle age groups, subjects with fewer filled teeth at enrollment showed the largest free/cost-sharing differences. No clear pattern of relationships was seen between plans and enrollment levels of missing or DMF teeth (Table 9).

PERIODONTAL DISEASE

The only significant relationships between plans and subgroups were for the 12- to 17-year-old group (Table 10). Teenagers from families of average or low education and those starting the study with average and high levels of periodontal disease—mainly gingivitis—had significantly better periodontal health if they were in the free rather than the cost-sharing plan.

Discussion

The HIE is the first large-scale, ran-

The long-term impact of better insurance coverage on oral health may be greater than reported.

domized controlled study to investigate the effects of dental insurance on oral health. As such, we believe that the results represent the actual effects of insurance on oral health and are not biased by subject self-selection.

The primary limitations of the study are the lack of a control group without any insurance coverage and the relatively brief time subjects participated in the study. With only half the US population enrolled in dental plans, the effect of not having any dental insurance is of interest. We know that average expenditures per person on the 95% plan exceeded those of the uninsured in the general population.⁷ This suggests that the positive association between plan generosity and oral health may have been even greater with an uninsured cohort in the study.

Length of enrollment is important because most dental diseases progress slowly, and many years may have to pass before treatment effects are seen, especially for tooth loss and periodontal dis-

Table 7 ■ Comparison of free and all cost-sharing plans: insurance plan with significantly* better oral health at exit from the study.

Oral health measures	Age group			
	6 - 11	12 - 17	18 - 34	35 - 64
Least decay	Free	Free	Free	†
Fewest missing	†	†	†	†
Most filled	Free	Free	Free	†
Lowest DMFT	†	†	†	†
Lowest PI	‡	Free	†	†

*P < .01, one-tailed test.

†No significant plan differences.

‡No periodontal data obtained for children younger than age 12.

Table 8 ■ The education subgroups* with significantly† better oral health outcomes at exit from the study when enrolled in the free (versus all cost sharing) plan.

Age group	Oral health measure			
	Decayed teeth	Missing teeth	Filled teeth	DMFT
6-11	Average and low	‡	Average and low	†
12-17	Average and low	Low	Average and low	†
18-34	‡	‡	‡	‡
35-64	‡	‡	‡	‡

*Years of schooling, average (and standard deviation): 6 to 11, 11.98 [2.44]; 12-17, 11.35 [2.88]. High (and low) subgroups are one standard deviation above (and below) the average.

†Plan difference significant, P < .01, two-tailed test.

‡No significant plan differences by subgroup.

Table 9 ■ The enrollment oral health status subgroups* with significantly† better oral health outcomes at exit from the study when enrolled in the free (versus all cost sharing) plan.

Age group	Oral health measure			
	Decayed teeth	Missing teeth	Filled teeth	DMFT
6-11	High and average	‡	High and average	‡
12-17	High and average	‡	Average	‡
18-34	High and average	‡	Average and low	Low
35-64	‡	‡	‡	‡

*Enrollment oral health status, average (and standard deviation). Decay: 6-11, 1.04 (1.28); 12-17, 2.76 (2.60); 18-34, 2.69 (2.64). Filled: 6-11, 0.76 (1.18); 12-17, 4.07 (3.38); 18-34, 9.19 (5.12). High (and low) subgroups are one standard deviation above (and below) the average.

†Plan difference significant, $P < .01$, two-tailed test.

‡No significant differences by subgroup.

ease. Accordingly, the long-term impact of better insurance coverage on oral health may be greater than reported here.

Our most important finding is that subjects younger than 35 years in the free plan were generally in better oral health than those in the cost-sharing plans at the end of the study. For these age groups, persons in the free plan had fewer decayed and more filled teeth, fewer missing teeth (12- to 17-year cohort from families with low education only), and less periodontal disease. These results suggest that better coverage does improve oral health. As a corollary, we can reasonably assume that the substantial increase in the number of people with dental insurance seen in the past 15 years has improved the oral health status of the population.

The magnitude of the cost-sharing effect is of particular interest. Although significant statistically, does it also have clinical importance? This is a difficult question to answer. First, the oral health improvements seen in a 3- to 5-year period are likely to be cumulative. As such, fewer teeth should be lost during the lifetime of an individual. Unfortu-

nately, we have no way of predicting the long-term cumulative effects of this reduction in decayed or missing teeth and periodontal disease. Second, we have little knowledge of the value that individu-

We cannot at present estimate how much money people would be willing to spend for specific incremental gain in oral health.

als place on their oral health; we cannot at present estimate how much money they would be willing to spend for a specific incremental gain in oral health. In essence, both individual and group purchasers of dental insurance will have to decide if the benefits associated with reduced cost sharing seen in this study are worth the greater expenditures.

The primary effect of less cost sharing appears to be on the treatment, not the

prevention of disease. The DMFT index, a measure of accumulated disease, did not decrease significantly as cost sharing decreased, as would be expected if decay and tooth loss were prevented.

The age cohorts showing the greatest response to cost sharing were teenagers (12 to 17 years) for caries and tooth loss and teenagers and young adults (18 to 34 years) for periodontal disease. For both groups, the incidence of caries and periodontal disease—mainly gingivitis—respectively, is particularly high. This may explain the responsiveness of the conditions to dental care.

In contrast, the 35- to 64-year-old group showed few plan differences in oral health outcomes. The reasons for this are not clear. Tooth decay is less of a problem in this age group, and periodontal disease is more advanced and perhaps not as responsive to dental treatment.

The substantial age-dependent response in oral health to cost sharing has implications for group purchasers of insurance. For the greatest improvements in oral health for the monies expended, initially covering children and teenagers and then incrementally phasing in adults has some advantages.

The analyses of the response of different subgroups of the population to cost sharing indicate that the least educated

and those with the poorest initial oral health tended to show significant reductions in decayed teeth and periodontal disease when they were enrolled in the free plan. Apparently, dental insurance benefits those subgroups most in need of care. This finding is important relative to current attempts to cut back publicly financed dental programs and to reduce employee dental benefits. These cutbacks are likely to hurt those with the poorest oral health.

The failure to discover subgroup trends other than those found in adolescents for periodontal disease is also notable. Evidently, adults from different educational and initial health status levels gain relatively equally from reduced cost sharing. The reasons for this finding are not clear, but perhaps periodontal services are generally underutilized in the population, suggesting that all subgroups might benefit from better financial access to care.

Perhaps periodontal services are generally underutilized in the population.

■ Conclusion

Our results suggest that reducing cost sharing for dental services will improve oral health for those younger than age 35 and especially for subgroups of the population with the poorest oral health. This implies that significant gains in oral health could be expected if coverage were extended to the millions of children, teenagers, and young adults who are without dental insurance.

How this information will influence the decisions of private and public group purchasers of insurance in their selection of health and other benefits remains to be seen. Only they can decide whether a greater investment in dental care is worth the additional expense.

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Table 10 ■ Education and enrollment oral health status subgroups with significantly* better periodontal health at exit from the study when enrolled in the free (versus all cost-sharing) plan.

Age group	Education\$	Enrollment periodontal disease†
12-17	Average and low	High and average
18-34	‡	‡
35-64	‡	‡

*Years of schooling, average (and standard deviation): 12-17, 11.32 (2.89); 18-34, 12.70 (2.41); 35-64, 12.11 (3.19).

†Plan differences significant, $P < .01$, two-tailed test.

‡No significant plan differences.

\$Enrollment periodontal index, average (and standard deviation), 12-17, 1.06 (.26); 18-34, 1.13 (.32); 35-64, 1.23 (.43). High (and low) subgroups are one standard deviation above (and below) the average.

Results suggest that reducing cost sharing for dental services will improve oral health for those younger than age 35 and especially for subgroups of the population with the poorest oral health.

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