SCIENTIFIC ARTICLES

Dental Insurance and Clinical Dental Outcomes in NHANES III

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Abstract

Objectives: *The National Health and Nutrition Examination Survey (NHANES III) 1988-1994 is one of the few nationally representative data sets with information on both private dental insurance and a clinical dental exam. The objective of this analysis was to examine the possible associations between private dental insurance and clinical exam outcomes, demographic variables, and dental visits.* ***Methods:*** *Using NHANES III data, analysis was limited to persons aged 20 years or older who had a dental exam and reported on their private dental insurance status. Initial analyses were based on comparisons between those with and without private dental insurance. Propensity scoring method was used to examine the effects of dental insurance on clinical exam variables.* ***Results:*** *The percentage of individuals with private dental insurance was significantly greater among non-Hispanic blacks, those with higher educational attainment, those living at/above the federal poverty level, and those with a dental visit in the past year compared to their respective counterparts. Those with untreated caries, those with a loss of attachment of greater than 4 mm, and those with 12-27 missing teeth were significantly less likely to have dental insurance (p < 0.05) than their respective counterparts.* ***Conclusions:*** *These results suggest that having private dental insurance is associated with better clinical oral health status.*

Key Words: Dental caries; dental insurance; national surveys; periodontal attachment loss; propensity score

Introduction

Studies have shown that individuals without medical insurance receive fewer preventive and diagnostic services, tend to be more severely ill when diagnosed, and receive less therapeutic care (1). The case is not as clear-cut for dental insurance, mostly due to the lack of clinical and administrative data available on oral health outcomes and dental insurance status. Associations between dental insurance and number of dental visits have been examined previously at the national level (2, 3, 4), however, to the knowledge of the authors, this study is the first to examine private dental insurance and clinical dental exam outcomes in a nationally representative data set.

Dental insurance provides a potential mechanism to make dental care more accessible to persons who may not otherwise seek oral health care. However, it is difficult to isolate effects on dental outcomes that are solely attributable to the presence of dental insurance, since dental insurance is associated with an array of factors/confounders, including employment, age, cultural factors, and levels of income and education, that may influence oral health (5).

In one of the largest studies of its kind to assess the association between dental insurance and the use of dental services, the Rand Health Insurance Experiment (6) randomly assigned families to different levels of insurance coverage for several years. Those with the lowest co-payments tended to use more dental services, and those with higher co-payments used fewer, suggesting that people are

price sensitive. This was especially true for participants having lower incomes. More recent studies have also noted a strong correlation between presence of private dental insurance and utilization of dental services (3,7).

Dental insurance effects on clinical outcomes in the Rand Health Insurance Study suggest that dental insurance, by reducing out-of-pocket cost, increases willingness to seek oral health care, which in turn improves oral health. These results were more pronounced in children and adolescents than in adults.

The purpose of this study was to investigate associations between private dental insurance and clinical exam outcomes, demographic variables and dental visits using data from the Third National Health and Nutrition Examination Survey (NHANES III). NHANES III is the only recent national dataset that has data from dental clinical exams as well as data on private dental insurance status. It is difficult to untangle the effects of having versus not having private dental insurance from confounding demographic characteristics that are associated both with having private dental insurance and with the clinical outcome being examined. One approach to this is the use of propensity scores, introduced by Rosenbaum and Rubin (8). The goal of using the propensity score methodology is to create a balance between different groups (a means for matching members of different groups based on a range of characteristics). Theoretically, this method is similar to an experimental design, but it is applied to
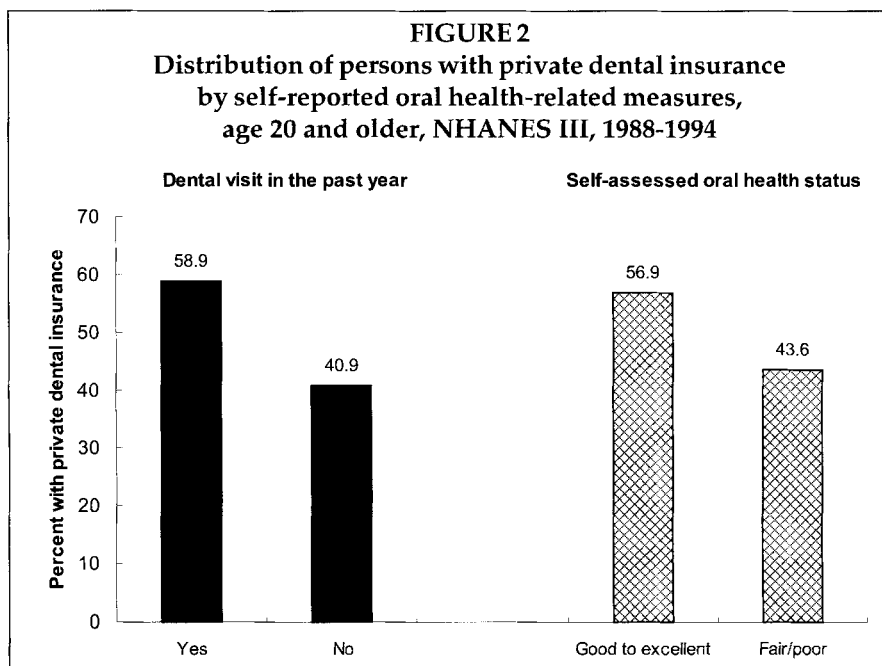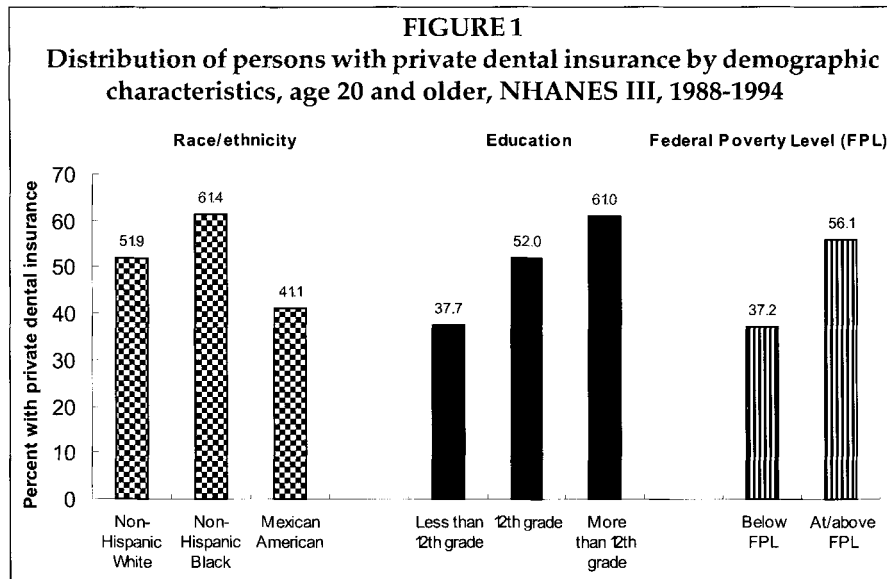
survey or observational studies and has the potential to reduce selection bias. The propensity score is the probability that an individual belongs to a naturally occurring experimental group (with-private-dental-insurance group in this case), based on the individual's background characteristics (covariates). Propensity scores have the advantage over standard matching techniques of summarizing information on background characteristics into a single summary score. After the propensity scores have been calculated, the treatment group (with-dental-insurance group) and the control group (without-dental-insurance group) can each be stratified into similar matched comparison groups based upon their propensity scores. For each stratum, the two groups of survey respondents that have similar propensity scores may be examined. It is hypothesized that private dental insurance will display a positive independent association with clinical oral health status among US adults.

Methods

The study population was drawn from participants in the NHANES III. NHANES III was a nationally representative cross-sectional survey of the US civilian, non-institutionalized population that was conducted by the National Center for Health Statistics between 1988 and 1994. NHANES III used a stratified, multistage probability sampling design (9). The oral health component included assessments for oral soft tissue lesions, dental caries, periodontal diseases, occlusal characteristics, and prostheses. More detailed information on this component of NHANES III has previously been described (10).

Four versions of the survey instrument were administered between 1988 and 1994. The lead-in question for dental insurance changed three times, with the main change being the reference time period. Private dental insurance variables were self-reported based on responses to the following questions:

Version 1: Is _ NOW covered by a health insurance that pays any part of dental care?

FIGURE 1

Distribution of persons with private dental insurance by demographic characteristics, age 20 and older, NHANES III, 1988-1994

FIGURE 2

Distribution of persons with private dental insurance by self-reported oral health-related measures, age 20 and older, NHANES III, 1988-1994

Version 2: Is _ covered by a health insurance plan? (If so,) Did any of these plans cover any part of dental care?

Versions 3-4: During the LAST MONTH was _ covered by one or more health insurance plans obtained privately or though an employer or union? (If so,) Did any of these plans cover any part of dental care?

These questions were combined in this analysis to form a single variable. If there was a positive response to either version of the questionnaire, the variable was coded as having dental insurance.

Data analysis was limited to individuals aged 20 years or older with one or more teeth who received a clinical dental exam from the NHANES staff and responded to questions on private dental insurance. Initial analyses were based on comparisons between those with and without private dental insurance using chi-square tests.

Stratification into quintiles of propensity score with dental insurance as an outcome created groups with limited variation in confounders. In order to examine the propensity score method, a logistic regression model was used to create the propensity

TABLE 1
Characteristics of dentate persons, 20 years and older, who received a dental exam as part of NHANES III, by dental insurance status, NHANES III, 1988-1994

	P-values	Have dental insurance N=5,331		Did not have dental insurance N=5,534	
		Percent	95% CI[†]	Percent	95% CI[†]
Overall	0.02	53.9*	50.6, 57.1	46.1*	42.9, 49.4
Age					
20-29	0.34	52.8	47.0, 58.7	47.2	41.3, 53.0
30-39	< 0.01	62.4*	58.6, 66.3	37.6*	33.7, 41.4
40-49	< 0.01	62.5*	57.4, 67.5	37.5*	32.5, 42.6
50-59	0.01	57.2*	52.1, 62.2	42.8*	37.8, 47.9
60-69	< 0.01	36.3*	31.6, 41.0	63.7*	59.0, 68.4
70-79	< 0.01	25.9*	21.0, 30.8	74.1*	69.2, 79.0
80 and older	< 0.01	17.1*	13.0, 21.2	82.9*	78.8, 87.0
Race/ethnicity[†]					
Non-Hispanic white	0.29	54.4*	51.5, 57.3	45.6*	42.7, 48.5
Non-Hispanic black	< 0.01	66.0*	61.7, 70.2	34.1*	29.8, 38.3
Mexican American	0.01	49.8	43.5, 56.1	50.2	43.9, 56.5
Gender					
Male	0.04	55.4*	52.1, 58.7	44.6*	41.3, 47.9
Female	0.02	55.9*	52.6, 59.1	44.1*	40.9, 47.4
Education					
Less than 12th grade	<0.01	51.5	47.3, 55.7	48.5	44.3, 52.7
12th grade	0.25	52.2	48.8, 55.6	47.8	44.4, 51.2
More than 12th grade	< 0.01	61.3*	57.4, 65.2	38.7*	34.8, 42.6
Federal poverty level (FPL)					
Below FPL	<0.01	39.9*	33.4, 46.4	60.1*	53.6, 66.6
At/above FPL	< 0.01	57.8*	54.6, 60.9	42.3*	39.1, 45.4
Dental visit during the past year					
Yes	< 0.01	59.1*	56.0, 62.1	40.9*	37.9, 44.0
No	<0.01	40.8*	36.3, 45.4	59.2*	54.6, 63.7
Smoking status					
Never smoked	0.01	55.0*	51.4, 58.6	45.0*	41.4, 48.6
Former smoker	0.16	52.9	48.6, 57.1	47.1	42.9, 51.4
Current smoker	0.22	53.2	48.4, 58.0	46.8	42.0, 51.6
Untreated caries (surface)					
Yes	<0.01	45.1*	41.1, 49.0	55.0*	51.0, 58.9
No	< 0.01	58.4*	55.4, 61.4	41.6*	38.6, 44.6
Loss of attachment >= 4mm[†]					
Yes	0.70	41.2*	36.8, 45.5	58.8*	54.5, 63.2
No	0.13	54.9*	51.9, 57.9	45.1*	42.1, 48.1
Loss of attachment >=6mm[†]					
Yes	0.46	46.9	37.3, 56.5	53.1	43.5, 62.7
No	0.14	54.7*	51.8, 57.7	45.3*	42.3, 48.2
Self-assessed oral health status					
Good or better	< 0.01	57.0*	53.8, 60.3	43.0*	39.7, 46.2
Fair or poor	<0.01	43.9*	39.7, 48.0	56.1*	52.0, 60.3
Missing teeth[†]					
0	0.35	56.6*	53.4, 59.7	43.4*	40.3, 46.6
1-3	0.65	57.9*	53.1, 62.4	42.2*	37.6, 46.7
4-11	0.57	54.6	48.9, 60.3	45.4	39.7, 51.1
12-27	0.01	39.0*	30.8, 47.2	61.0*	52.8, 69.2

* Statistically significant difference between those with and without private dental insurance (p<0.01).
[†]CI, confidence interval
[‡]Age standardized to the Year 2000 US population.

score. The variables included in the model were age (20-29, 30-39, 40-49, 50-59, 60-69, 70-79, 80 and older), education (less than 12th grade, 12th grade, more than 12th grade), poverty level quartiles (based on the weighted distribution of the sample), region (northeast, midwest, south, west), Metropolitan Statistical Area (MSA: non-MSA vs. MSA), and smoking status (never, current, former). Smoking status was included in the analyses because it has been reported to be associated with periodontal disease (11), untreated caries (12), and dental care utilization (13). Individuals with and without dental insurance in each propensity score quintile were compared to examine effects of dental insurance on the clinical exam variables. The clinical exam variables of interest were mean loss of attachment (measurement of periodontal disease), untreated decay, and missing teeth. Due to the complex sample design of NHANES III, final sample weights were used to produce unbiased population estimates based on the 1990 Census estimate of the U.S. population. The software package SUDAAN version 8.0 (Research Triangle Park, NC) was used for all calculations and analyses.

Results

Among persons 20 years old and older who received a dental exam, 53.9 percent had private dental insurance (Table 1).

Among this group, there was a statistically greater likelihood of having dental insurance than not having dental insurance. Non-Hispanic blacks were more likely to have private dental insurance than were non-Hispanic whites or Mexican-Americans (p < 0.01, Figure 1).

The percentage of persons with private dental insurance increased with higher levels of educational attainment. The increase was significant for persons with more than a 12th grade education compared to those with less than a 12th grade education. Persons living at/above the Federal poverty level (FPL) were more likely to have private dental insurance than were persons living below the Federal poverty level (p < 0.01).

TABLE 2
Propensity scores of dentate persons 20 years and older by demographic and clinical variables, NHANES III, 1988-1994

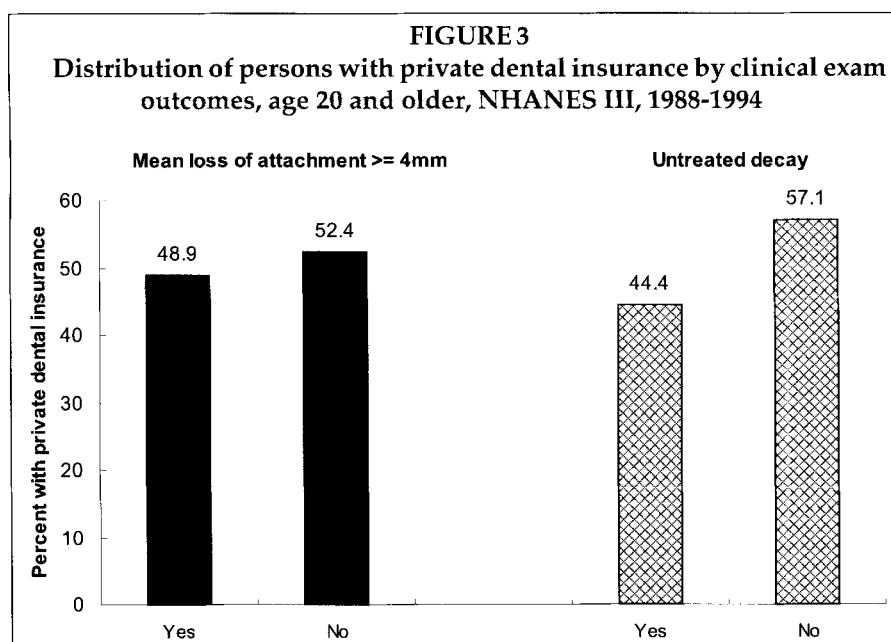|	Score = 1			Score = 2			Score = 3			Score = 4			Score = 5		
	N	%	95% CI*	N	%	95% CI*	N	%	95% CI*	N	%	95% CI*	N	%	95% CI*
Age															
20-29	452	25.9	21.0, 30.9	521	29.9	25.9, 34.0	472	28.5	23.0, 33.9	420	21.4	18.4, 24.3	261	14.2	11.5, 17.0
30-39	380	22.3	18.2, 26.3	484	27.6	23.9, 31.4	470	26.6	22.4, 30.7	493	28.7	25.1, 32.2	474	27.1	23.5, 30.8
40-49	272	13.8	11.3, 16.3	320	15.5	13.0, 18.0	299	16.6	14.2, 19.0	410	22.5	19.8, 25.3	462	26.7	22.6, 30.8
50-59	190	8.8	7.3, 10.3	207	9.8	7.4, 12.2	217	11.2	8.8, 13.5	264	12.1	10.1, 14.1	319	15.7	13.4, 18.0
60-69	323	12.7	9.7, 15.6	214	9.1	7.4, 10.7	221	9.2	7.2, 11.2	238	8.8	7.1, 10.5	241	10.3	7.8, 12.7
70-79	236	11.6	9.3, 14.0	140	6.4	4.7, 8.0	151	6.0	4.4, 7.5	148	4.9	3.6, 6.1	148	4.5	3.0, 6.0
80 and above	145	4.9	3.5, 6.3	64	1.7	1.0, 2.4	88	2.1	1.2, 2.9	88	1.6	1.0, 2.2	79	1.5	0.5, 2.4
Race/Ethnicity															
Non-Hispanic white	549	64.5	55.9, 73.2	659	72.5	67.9, 77.1	912	80.2	77.2, 83.1	1145	84.3	81.4, 87.3	1252	87.7	85.7, 89.7
Non-Hispanic black	536	15.5	10.9, 20.2	626	14.4	11.5, 17.2	541	10.4	8.6, 12.1	517	7.8	6.4, 9.2	389	5.2	4.1, 6.3
Mexican American	861	13.0	6.8, 19.2	614	6.8	5.2, 8.4	396	3.4	2.7, 4.0	325	2.2	1.7, 2.7	268	2.0	1.4, 2.5
Other	52	7.0	3.8, 10.2	51	6.4	4.1, 8.7	69	6.1	4.1, 8.1	74	5.6	3.3, 8.0	75	5.1	3.1, 7.1
Gender															
Male	913	42.7	38.9, 46.4	990	47.8	45.1, 50.6	870	46.1	43.2, 49.0	942	47.9	45.4, 50.4	1052	52.0	49.0, 55.0
Female	1085	57.4	53.6, 61.2	960	52.2	49.4, 54.9	1048	53.9	51.0, 56.9	1119	52.1	49.7, 54.6	932	48.0	45.0, 51.0
Education															
Less than 12th grade	1599	71.5	66.6, 76.4	910	35.6	31.1, 40.2	348	14.4	11.4, 17.5	109	4.0	2.4, 5.6	0	0.0	0.0, 0.0
12th grade	399	28.5	23.7, 33.4	863	53.1	48.9, 57.3	902	46.1	41.4, 50.8	778	37.2	32.7, 41.7	377	17.4	14.0, 20.7
More than 12th grade	0	0.0	0.0, 0.0	177	11.2	8.0, 14.4	668	39.5	33.8, 45.2	1174	58.8	53.3, 64.3	1607	82.6	79.3, 86.0
Federal poverty level (FPL)															
0 - <1.394 FPL	1606	74.0	68.8, 79.1	682	27.8	22.6, 33.0	185	7.9	5.3, 10.4	0	0.0	0.0, 0.0	0	0.0	0.0, 0.0
1.394 - <2.462 FPL	392	26.0	20.9, 31.2	1018	56.1	51.5, 60.6	778	36.2	31.4, 41.1	289	10.6	7.7, 13.6	0	0.0	0.0, 0.0
2.462 - <3.788 FPL	0	0.0	0.0, 0.0	250	16.2	12.4, 20.0	848	50.1	46.0, 54.3	1039	49.2	43.9, 54.5	338	13.7	10.2, 17.2
3.788-12 FPL	0	0.0	0.0, 0.0	0	0.0	0.0, 0.0	107	5.8	3.6, 8.0	733	40.2	33.0, 47.3	1646	86.3	82.8, 89.8
Mean loss of attachment (mm)															
0 - <3	1541	87.9	85.0, 90.7	1613	91.7	89.9, 93.4	1672	94.7	93.4, 96.1	1830	96.7	95.4, 98.1	1727	97.1	96.2, 98.0
3 and above	228	12.2	9.3, 15.1	179	8.3	6.6, 10.1	114	5.3	4.0, 6.6	81	3.3	1.9, 4.6	80	2.9	2.0, 3.8
Decayed surfaces															
0	974	49.0	44.6, 53.3	1079	58.6	54.3, 63.0	1339	77.1	73.7, 80.5	1574	81.5	78.4, 84.7	1631	86.6	84.4, 88.8
1 - 2	364	19.2	14.0, 24.4	341	16.6	13.2, 20.0	226	8.6	6.8, 10.4	249	9.9	7.8, 11.9	185	7.4	5.6, 9.3
3 - 6	316	15.3	12.8, 17.7	278	14.4	11.3, 17.5	185	7.4	5.7, 9.1	136	5.2	3.4, 7.0	97	3.9	2.7, 5.0
7 - 91	344	16.6	13.2, 20.0	252	10.4	8.7, 12.1	168	6.9	5.3, 8.5	102	3.4	2.1, 4.8	71	2.2	1.3, 3.0
Missing teeth															
0	417	19.1	15.1, 23.2	494	30.6	26.4, 34.8	558	34.3	30.4, 38.1	674	39.2	35.3, 43.1	703	44.2	41.6, 46.9
1 - 5	745	39.6	36.1, 43.2	781	38.4	35.1, 41.7	748	40.4	37.3, 43.5	858	41.1	38.4, 43.8	838	38.4	36.0, 40.7
6 and above	836	41.2	36.8, 45.6	675	31.0	27.0, 35.0	612	25.4	21.9, 28.9	529	19.7	16.6, 22.8	443	17.4	15.5, 19.3

* CI, confidence interval

TABLE 3
Propensity scores of dentate persons aged 20 years and older by dental insurance status and clinical exam variables, NHANES III, 1988-1994

	Score = 1		Score = 2		Score = 3		Score = 4		Score = 5	
	With dental insurance	Without dental insurance	With dental insurance	Without dental insurance	With dental insurance	Without dental insurance	With dental insurance	Without dental insurance	With dental insurance	Without dental insurance
Mean loss of attachment (mm)										
0 - <3	90.3	86.9	93.6	90.4	95.8	93.5	96.8	96.6	97.6	96.0
95% CI‡	85.6, 95.0	83.7, 90.1	90.8, 96.4*	88.4, 92.3*	94.0, 97.6	91.5, 95.6	95.1, 98.6	94.8, 98.3	96.7, 98.5	93.8, 98.1
3 and above	9.7	13.1	6.4	9.7	4.2	6.5	3.2	3.4	2.4	4.0
95% CI‡	5.0, 14.4	9.9, 16.4	3.6, 9.2*	7.7, 11.6*	2.4, 6.1	4.4, 8.5	1.4, 4.9	1.7, 5.2	1.5, 3.3	1.9, 6.2
Decayed surfaces										
0	51.4	48.0	61.3	56.8	77.3	76.9	84.7	76.7	87.1	85.4
95% CI‡	41.9, 60.9	43.7, 52.2	55.3, 67.4	52.0, 61.6	73.0, 81.6	72.6, 81.2	81.4, 88.0*	72.4, 81.0*	84.9, 89.4	81.6, 89.3
1 - 2	17.4	19.9	17.0	16.4	7.0	10.3	7.9	12.8	7.3	7.6
95% CI‡	9.7, 25.0	15.3, 24.6	11.9, 22.0	12.8, 19.9	5.0, 9.1†	7.5, 13.1†	5.5, 10.4*	9.6, 16.0*	5.2, 9.4	4.9, 10.4
3 - 6	14.2	15.7	12.0	16.0	8.1	6.6	5.3	5.1	3.7	4.1
95% CI‡	10.4, 18.1	12.1, 19.2	8.1, 15.9*	12.6, 19.3*	5.8, 10.5	4.7, 8.5	3.3, 7.2	2.5, 7.7	2.3, 5.1	2.4, 5.8
7 - 91	17.0	16.4	9.7	10.9	7.5	6.3	2.1	5.4	1.9	2.8
95% CI‡	11.9, 22.1	12.4, 20.5	8.0, 11.4	8.1, 13.7	5.1, 9.9	4.0, 8.6	1.2, 3.0*	2.6, 8.3*	0.9, 2.8	1.5, 4.1
Missing teeth										
0	20.1	18.7	32.1	29.6	35.5	33.0	38.9	39.6	48.0	36.4
95% CI‡	14.1, 26.2	14.5, 23.0	26.0, 38.2	24.2, 34.9	31.0, 40.0	27.1, 38.9	34.6, 43.2	34.3, 44.9	44.4, 51.6*	32.2, 40.6*
1 - 5	40.8	39.2	42.1	35.9	41.5	39.2	43.1	38.1	37.1	41.1
95% CI‡	34.0, 47.7	35.6, 42.8	36.5, 47.8	31.0, 40.7	36.7, 46.2	35.0, 43.4	39.6, 46.6†	34.1, 42.1†	34.2, 39.9†	37.6, 44.6†
6 and above	39.1	42.1	25.8	34.5	23.1	27.8	18.0	22.3	14.9	22.5
95% CI‡	33.7, 44.5	36.7, 47.5	21.2, 30.4*	29.5, 39.6*	18.1, 28.0	23.7, 31.9	14.0, 22.0**	18.5, 26.1†	12.6, 17.3*	18.5, 26.5*

* Statistically significant (p < 0.05) difference between those with and without dental insurance in the propensity score quintile.
† Statistically significant (p < 0.10) difference between those with and without dental insurance in the propensity score quintile.
‡ CI, confidence interval

FIGURE 3
Distribution of persons with private dental insurance by clinical exam outcomes, age 20 and older, NHANES III, 1988-1994

In terms of use of dental care services, a significantly greater percentage of persons who visited a dentist during the past year had private dental insurance than those without dental visits (p < 0.01, Figure 2).

Persons with private dental insurance were more likely to have a good or better self-assessed oral health status than a fair or poor rating (p < 0.01).

When outcomes of the NHANES III clinical dental exam were ana-

lyzed, it was found that persons with private dental insurance were more likely to not have untreated dental caries than untreated dental caries (p < 0.01, Figure 3).

Persons with private dental insurance were more likely not to have a mean loss of attachment greater than or equal to 4 mm (p < 0.01) and they were also more likely to be missing 11 or fewer teeth (p < 0.01, Table 1).

Propensity scores for the outcome of having dental insurance were calculated and the population divided into propensity score quintiles to examine the distribution of the demographic and clinical variables within each quintile (Table 2).

A score of 1 represented the lowest quintile (that is the quintile least likely to have dental insurance) and 5 represented the highest quintile (most likely to have dental insurance). Trends are seen in Table 2 as expected across quintiles of the propensity score. A statistically significant association (p<0.05) was found be-

tween 6 or more missing teeth and the absence of dental insurance in the highest and second lowest quintile of propensity score (Table 3).

Other associations were found between loss of attachment of <3 mm and having dental insurance, a loss of attachment of 3 or more mm and absence of private dental insurance, no untreated dental caries and having private dental insurance, and lack of missing teeth and having private dental insurance. However, these were not significant at the p<0.05 level. (See the Introduction for more details on propensity scores.)

Discussion

Approximately 54% of the population included in this study (defined by the analytic file) has private dental insurance. This population does not include those without private medical insurance (i.e. those with no insurance and those with public medical insurance), who are very unlikely to have private dental insurance, or those who did not respond to the relevant survey questions. Estimates for the percentage of those with private dental insurance in NHANES III, aged 20 years or more, were 50.9% for the dentate population, and 48.8% when including both the dentate and edentulous. While the analytic group appears relatively similar to the overall NHANES III sample in terms of dental insurance (54%, 51%, 49%), this study does not include those in the potentially lowest medical tier of the US population, e.g., the totally uninsured and those on public assistance. While it can be suggested that the benefits of dental insurance shown in this analysis would apply to this group as well, if they had access to dental insurance, data is not included that shows this directly.

No questions were asked to determine how long respondents had dental insurance, whether they had dental insurance as children, etc. This is a limitation of these analyses since early dental care may influence adult clinical dental status. This information is missing from all national population based health surveys of which the authors of this study are aware.

These analyses showed associations between having private dental insurance, demographic variables and visits to the dentist as seen in other studies providing some level of validation for combining different questionnaire versions into a single variable (2, 3). Although there are some differences in the wording and time frame of the insurance question, these are relatively slight and combining the different questionnaire versions enables analyses with significantly higher sample sizes.

A greater percentage of non-Hispanic blacks than non-Hispanic whites or Mexican-Americans had private dental insurance. The results of the study were compared to data from NHANES 1999-2000, BRFSS 1997 and 2001, and MEPS 2000. All of these surveys showed that a greater percentage of non-Hispanic blacks who had at least one tooth had private dental insurance (results available from the author). This demonstrates that results found here are in accord with results obtained from several other national population-based surveys. It would be interesting to examine this observation further in multiple data sets addressing such issues as non-response bias, the percentage of those in various racial groups without insurance who are edentulous, etc.

Examination of socioeconomic status indicates that these results are similar to other studies. Looking at various levels of education it becomes clear that the differential in having private dental insurance is associated with those who completed more than the 12th grade. There is also a statistically significant association between having private dental insurance and living about the federal poverty level. In general, those with higher incomes have propensity scores associated with private dental insurance.

The one variable representing health behavior (smoking) is associated with having dental insurance: those who have never smoked are more likely to have dental insurance, as expected given the literature on the similarities of health behaviors. Thus, both of these socioeconomic status

and health behaviors variables show a threshold rather than a gradient effect.

To the knowledge of the authors this is the first study to show an association between having private dental insurance and positive outcomes of a clinical dental exam (lack of decay, lower loss of attachment, fewer missing teeth) in a nationally representative survey. Propensity scores were used to try to untangle the effects of dental insurance status and clinical dental outcomes. Limitations of this methodology include multiple comparison issues, and possible omission from the model of identified but weak confounders as well as unidentified confounders. Sample size is also reduced to the size of each stratum. Associations shown in Table 1 motivated the use of propensity analysis since they show that several demographic variables known to be associated with positive clinical dental exam results are also strongly associated with having dental insurance. Analyses within quintiles of propensity scores in this study led to suggestions that having dental insurance is associated with clinical dental exam outcomes independent of confounders. For example, a statistically significant association (p<0.05) was found between six or more missing teeth and the absence of dental insurance in the highest and second lowest quintile of propensity score (Table 3). It is possible that missing teeth may be a proxy for type of health-seeking behaviors, since adults who chose to have carious or periodontally involved teeth extracted may have less appreciation for preventive treatments or understanding of the importance of retained teeth. Poor adults have been reported to have a significantly higher number of missing teeth than do wealthier adults (14), and insurance coverage may function to reduce this disparity in missing teeth by reducing the wealth disparity and its impact on access to care. It may be that poorer adults have access to care to have teeth removed but not for more involved restorative treatments. Also, clinical dental health represents the results of dental care over long peri-

ods of time, particularly for older adults. Prolonged periods of lack of access to dental services, even in the presence of current insurance, might be associated with poor clinical status. This would weaken any association between current dental insurance and clinical dental health status. In order to fully address this issue, a complete history of dental insurance over the course of respondents' lives would be needed.

The purpose of dental insurance is to increase access to dental care with the long-term goal of improving oral health status. An independent association between private dental insurance and positive clinical outcomes was demonstrated. Policy makers may be guided by the implication of this finding that a loss of dental insurance, whether from loss of employment or the discontinuation of benefits by an employer, might be expected to result in a long-term worsening of oral health status. This may well result in increased overall health costs. Remaining questions to further guide policy include whether varying the level and extent of benefits would result in specific changes in clinical

dental outcomes, and whether specific demographic groups display more oral health status improvement from similar insurance benefits. Further studies and/or additional methodologies are needed to resolve this issue.

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