Explaining Dental Utilization Behavior

Allyson Ross Davies, Harris M. Allen,
Willard G. Manning, Susan A. Holtby,
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PREFACE

This report examines the factors other than dental health insurance that explain people's use of dental health services. The analyses use data from the RAND Health Insurance Experiment, a large-scale social experiment designed to study the effects of health insurance on the use of health services, health status, and attitudes toward care.

Analyses of the effects of coinsurance on dental utilization and oral health are reported in several publications. The effects of varying levels of cost-sharing on utilization are discussed in W. G. Manning, H. L. Bailit, B. Benjamin, and J. P. Newhouse, "The Demand for Dental Care: Evidence from a Randomized Trial in Health Insurance," *Journal of the American Dental Association*, June 1985 (also published in the RAND Report series as R-3255-HHS, August 1986). The effects of coinsurance on oral health status are discussed by H. L. Bailit et al., "Does More Generous Dental Health Insurance Coverage Improve Oral Health?" *Journal of the American Dental Association*, May 1985. The relationship between cost-sharing and oral health behavior is the topic of an article by H. L. Bailit et al., "Generosity of Dental Insurance and Oral Health Behavior," *American Journal of Public Health* (in press). Preliminary work on the relationship between dental use and explanatory variables is discussed by A. R. Davies, H. L. Bailit, and S. Holtby, "Oral Health Status in the United States: Will Improved Health Lead to Decreased Demand for Dental Services?" *Journal of Dental Education*, June 1985.

The research reported herein was performed under the project "Explaining Dental Utilization Behavior" from the National Center for Health Services Research and Technology Assessment, Washington, D.C.

SUMMARY

The analyses reported here were designed to address three questions.

- What explains the substantial percentage of people with dental health insurance who do not use any dental care during a year?
- What underlying (and often unmeasured) differences in need, attitudes, or continuity manifest themselves as observed sociodemographic group variations in use of dental care?
- Do the same or different factors account for care-seeking and for amount of care once an individual enters the system?

Answers to these questions can provide important information to policy discussions regarding alternative strategies to increase the appropriate use of dental services and to improve social equity in the receipt of care. Using data from RAND's Health Insurance Experiment (HIE), a large-scale social experiment designed to study the effects of health insurance on utilization, health status, and attitudes toward care, we built and tested multivariate models designed to address these questions by identifying the factors that explain the probability of use and the amount of use (expenditures) by adults and by children.

Recognizing that most studies have explained utilization with variables measured after use occurred, we examined whether and how conclusions differ between a model designed to forecast subsequent utilization and the more common "postdictive" model. Because the attitude-behavior relationship may deteriorate over time as attitudes change, we studied the sensitivity of our conclusions to the length of time between measurement of explanatory variables and use of dental services.

For both adults and children, we examined two dependent variables: the probability of use and expenditures by users (the log of total dollars spent by those who made at least one visit). For adults, we also distinguished preventive and illness-related services for each of these definitions of use. Explanatory variables were grouped in several categories, including oral health status (clinically assessed and self-reported); general health perceptions; satisfaction with care; health-related beliefs, knowledge, and attitudes; continuity of care; and sociodemographics. In analyses of children's utilization, several of these categories were represented by measures pertaining to the parent (satisfaction with dental care; health-related beliefs, knowledge, and attitudes; and continuity of dental provider).

To summarize results in terms of our hypotheses, we found that for the clinically assessed oral health measures, our hypotheses were generally confirmed. Those in poorer health status were less likely to use dental services; when they did, they spent more. For adults, findings for the self-report oral health measures depended on the type of service and the measure considered. For preventive care, those who reported poorer health status (needed cleaning, had bleeding gums) were less likely to obtain services. For illness-related care, those who reported better health status (had toothaches, more impact of dental disease) were less likely to use such services. For children, only the measure bleeding gums was related to probability of use. As with the clinically assessed measures for children, this relationship indicated that children in poorer health by parental report were less likely to obtain care.

Findings regarding relationships between general health perceptions and utilization for adults ran counter to our hypothesis of an inverse relationship. Adults who reported themselves in poorer overall health were *less* likely to use such services. We observed no association between perceived health and dental expenditures for adults. Confirmation for this relationship was considerably weaker in the children's analysis, where only parental perceptions of the child's resistance to illness related to use. As expected, perceived greater resistance was associated with a smaller likelihood that the child would obtain care, but unexpectedly with larger expenses once care was obtained.

The less satisfied, as expected, were less likely to obtain dental services for themselves and their children. Findings regarding the association between satisfaction and expenditures by adults ran counter to our hypothesis. Adult users who were more satisfied (particularly with costs, as well as with care in general) spent *less* on illness-related care in the following year. Also unexpectedly, expenditures on children who used dental care were unrelated to parental satisfaction.

Our hypothesis regarding the relationship between utilization and health-related beliefs, knowledge, and attitudes received weak support in analyses of adults. The few measures in this category that were significantly associated with use explained probability of use; generally, adults with less favorable beliefs and attitudes were less likely to obtain services themselves. Although knowledge about medical care was unrelated to use by adults, children with less knowledgeable parents were less likely to get dental care, as expected. Contrary to our hypothesis, expenditures by users and parental knowledge were unrelated. Again contradicting our hypothesis, parents' health-related attitudes and beliefs were unrelated to the probability that children would obtain care, and children of parents with less favorable attitudes toward providers spent more once they used dental care.

Our findings regarding the relationship between provider continuity and utilization confirmed our hypothesis in analyses of both children and adults. Those with less continuity were less likely to use care. Although not hypothesized, users with less provider continuity spent significantly more on all dental services.

When examined separately, most explanatory categories were significantly associated with probability of use for adults. Exceptions were the absence of significant associations between the less common self-report oral health measures (need cleaning, impact of disease) and probability of illness-related use, and between general health perceptions and probability of both illness-related and any use. All but two explanatory categories were significantly related to expenditures by adult users; those that were significant explained expenditures on illness-related (and thus total) but not preventive services. Unrelated to expenditures were two categories: general health perceptions and health-related beliefs, knowledge, and other attitudes.

In analyses of children's utilization, most explanatory categories were significantly related to at least one component of utilization, although less frequently in the hypothesized direction than observed in our analyses of adults. Exceptions were the absence of significant associations between parent's health-related beliefs and attitudes and probability of children's use, between parent's satisfaction with own dental care and expenditures, and between parent's knowledge of the medical care system and either definition of utilization.

When the relative contributions of the explanatory categories were assessed for adults, we concluded that those less likely to use were those who were in poorer health, had less favorable health-related beliefs and attitudes, and were less likely to have seen the same dentist previously.

We found that when we considered underlying group differences among adults in need, attitudes, and continuity, observed variation in probability of use by sociodemographic subgroups was substantially reduced. In this sample, underlying differences completely eliminated observed variation in use by race and gender. The categories that accounted for this reduction or elimination of sociodemographic effects on probability of use included oral health status (particularly the number of filled and decayed teeth and periodontal disease), continuity of dental provider, and beliefs in self-care.

Our data indicated substantial postdiction bias in models of adults' dental use. The bias generally caused overestimates of the importance of such explanatory variables as satisfaction with dental care, health-related beliefs and attitudes, and continuity of care. We found no evidence of any significant decrement in explanatory power with longer

intervals between the measurement of the explanatory variables studied (all categories except oral health status and knowledge about the medical care system) and use of dental services.

For dental health services research, we recommend:

- Continued work on development of models to explain children's use and nonuse of dental health services;
- Caution against testing hypotheses or predicting use of dental care based on results from studies that "postdict" use;
- Use of more than one variable to define multidimensional explanatory categories (e.g., health, attitudes);
- Analysis of separate explanatory models for the probability of dental care and for the level of use by those who obtain services;
- Development or use of improved measures of several explanatory variables, including perceived oral health status, dental-specific beliefs and attitudes, and value placed on oral health; and
- Design and fielding of a multi-year panel study that would address many of the questions of interpretation left unanswered by our research, and in particular would distinguish the unique effects of previous use and current oral health status on the probability of subsequent use.

We recommend that dental health policymakers consider interventions:

- Targeted to low-income and less-educated groups, and to children (and their parents) more generally;
- Designed to alter such perceptual barriers as lack of knowledge or belief that dental care can improve oral health and to reduce the tendency to overestimate (in relation to clinical assessment) oral health status; and
- Designed to increase the availability of defined sources of dental care.

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I. INTRODUCTION

BACKGROUND

In a recent advertisement, a dental service plan queried "wouldn't you go to the dentist if it was free?" and went on to answer "of course you would." However, reduction or elimination of financial barriers to dental services has only a small effect on whether people obtain care during the year (Wan and Yates, 1975). Such conclusions were confirmed by results reported from the randomized controlled trial of dental insurance carried out during RAND's Health Insurance Experiment. Manning et al. (1985, 1986) found that even with free dental care about 34 percent still did not use dental services annually; among those with some level of cost-sharing for dental care, 48 to 51 percent used no services annually.

National data on changes in dental insurance coverage and utilization patterns further underscore these findings. The proportion of the U.S. population with dental health insurance benefits increased markedly during the 1970s, from 2 percent in 1967 to 38 percent in 1981 (Health Insurance Association, 1983). Despite this change, the percentage of the U.S. general population that made no use of dental services during a 12-month period decreased only slightly, from 58 percent in 1963–64 to 50 percent in 1978–79 (National Center for Health Statistics, 1982a, the most recent published survey). If reduction or elimination of financial barriers has had so little apparent effect, we are left with the question, What explains the substantial percentage of people with dental health insurance who do not make any use of dental care during a year?

Previous studies have documented various factors associated with utilization (and nonutilization) of services. For example, many studies illustrate relationships between sociodemographic characteristics and utilization. Poor, black, and less-educated groups are less likely to use dental services than their more socioeconomically advantaged counterparts (National Center for Health Statistics, 1981, 1982a). Such differences persist despite changes during the past decade that were expected to increase the probability of use, including a substantial rise in the dentist-to-population ratio (National Center for Health Statistics, 1982b) and the financing and delivery of dental care to low-income groups through Medicaid and other public programs. Because there are few *a priori* reasons to believe that sociodemographic characteristics of themselves (other than income, perhaps) cause nonutilization,

recognition of differences in utilization patterns across population subgroups raises another important question: What underlying (and often unmeasured) differences in need or attitudes manifest themselves as observed sociodemographic group variations in use of dental care?

Finally, many previous studies have not been able to distinguish the probability of use, which is more likely to be influenced by the individual, from the amount of use, which is more likely to be under the provider's influence or control. Thus, a third important question becomes: Do the same or different factors account for care-seeking and for amount of care once the individual enters the system?

Answers to the questions posed above can provide important information to policy discussions regarding alternative strategies to increase the appropriate use of dental services and to improve social equity in the receipt of care. Using data from RAND's Health Insurance Experiment (HIE), a randomized controlled trial of the effects of health insurance on utilization and health status (Newhouse, 1974), we have built and tested multivariate models designed to address these questions by identifying the factors that explain the probability of use and the intensity of use of dental care by adults and by children.

In particular, our analyses were designed to:

- Replicate analyses from previous bivariate studies of variables thought to explain dental utilization behavior and extend such analyses to variables not commonly found in utilization models (e.g., satisfaction and other attitudinal measures);
- Identify those independent variables within each of the major categories that best represent that category in explaining dental use;
- Identify factors that best explain use and nonuse of dental care services;
- Determine whether conclusions regarding these explanatory factors depend on the definition of utilization (e.g., use/nonuse of dental care vs. expenditures by users, use of preventive vs. illness-related services); and
- Cross-validate (where sample size permitted) the best explanatory models to test the generalizability of results.

In addition, we were interested in exploring the implications of two important methodological problems on conclusions regarding what factors explain dental utilization behavior. Recognizing that most studies have explained utilization with variables measured *after* utilization occurred, we examined whether and how conclusions differ in a predictive model (in the sense of forecasting subsequent utilization) vs. a

"postdictive" one. Finally, because the attitude-behavior relationship may deteriorate with time as attitudes change, we examined the sensitivity of our conclusions to the length of the interval between measurement of explanatory variables and use of dental services.

The work reported here represents conceptual and methodological advances over previous studies of dental utilization in several respects:

- We used a prospective database to examine the explanatory power of variables assessed at the outset of the year on utilization during the subsequent year. With few exceptions (Manning et al., 1985, Rossiter, 1982), previous studies had to rely on retrospective designs to "forecast" utilization with variables assessed *after* services were used.
- We included a comprehensive set of explanatory variables—oral health status (clinically assessed and self-reported), general health status, satisfaction with dental care, provider continuity, health-related beliefs, knowledge, and attitudes, and sociodemographic characteristics. Although there are noteworthy exceptions (Haefner, 1974; Holtmann and Olsen, 1976; Kegeles, 1963a,b; Kriesberg and Treiman, 1960; Wan and Yates, 1975), most earlier multivariate studies chiefly examined socioeconomic factors (e.g., Manning et al., 1985, 1986; Manning and Phelps, 1978a, 1978b; Phelps and Newhouse, 1974; Rossiter, 1982).
- Our data on utilization came directly from claims submitted by dentists or participants during the year under study. Such data provide more accurate and detailed information than do self-reports of dental use recalled for the past year, a data collection method common to earlier studies (Andersen, Lion, and Anderson, 1976; Newman and Anderson, 1972).
- We examined separately the probability of use and, conditional on use having occurred, the level or intensity of use. For each, we distinguished overall use, use of preventive services, and use of illness-related services. As Wan and Yates (1975) have noted, distinguishing these aspects of use allows us to examine whether the same or different variables explain probability of use and level of use (for users), as well as variations in the factors that explain the use of different types of dental services. With notably few exceptions (e.g., Manning et al., 1985, 1986; Rossiter, 1982), most earlier work either concentrated on the probability of any use (e.g., Newman and Anderson, 1972) or confounded probability of use and amount of use by users (Bloom, 1982; Evashwick, Conrad, and Lee, 1982; Givens, 1979;

Holtmann and Olsen, 1976; Jack and Ries, 1981; Newman and Larsen, 1980; Trevino and Moss, 1984; Wilder, 1984).

- All subjects in our analyses had dental insurance, and the HIE's randomized design ensured that the amount of cost-sharing was not correlated with sociodemographic characteristics or oral health status. Previous studies that included insurance as an explanatory factor (Grembowski, Conrad, and Milgrom, 1985; Newhouse and Phelps, 1979; Phelps and Newhouse, 1974) studied samples in which insurance was confounded with sociodemographic characteristics (particularly employment, education, and income).

THE HEALTH INSURANCE EXPERIMENT

Sites and Eligibility Requirements

The experiment ran from 1976 through 1982 in the sites included in the analysis (Seattle, Washington; Fitchburg, and Franklin County, Massachusetts; Charleston, and Georgetown County, South Carolina). Our analyses excluded enrollees from the Dayton site, where dental benefits were phased in on a different schedule (Manning et al., 1985). Seattle began fluoridation in 1970, and Fitchburg in 1975; Franklin County and Charleston have no fluoridation, and Georgetown County is naturally fluoridated. Sites were not selected to show variation in fluoridation status, however, but in city size and waiting times to appointments.

Except for certain intentional exclusions, the sample was representative of the general populations in the sites studied. The experiment excluded families with family heads older than 62 years; families with annual incomes over $56,000 (in 1983 dollars), some 3 percent of families contacted; those eligible for the Medicare disability program; the institutionalized; the military and their dependents; and veterans with service-connected disabilities.

Insurance Plans and Benefits

The HIE assigned each participating family to one of several insurance plans that varied cost-sharing requirements for dental and medical care. The coinsurance rates (or percentage of the bill paid by the family) were 0 (free), 25, 50, or 95 percent for all health services.[1]

[1]One plan had a 25 percent coinsurance rate for inpatient and outpatient medical services and a 50 percent rate for dental and outpatient mental health services. In this as in preceding analyses of HIE data (Bailit et al., 1985; Manning et al., 1985, 1986), we combined this plan with the plan that had a 50 percent coinsurance rate for all services, because both had a 50 percent rate for dental services.

Each of these plans limited out-of-pocket expenditures to 5, 10, or 15 percent of family income, up to a maximum dollar expenditure (MDE) of $1000 annually. Once the MDE was satisfied, the plan fully reimbursed all expenditures. Some families were assigned to a plan that had a 95 percent coinsurance rate for all outpatient medical, dental, and mental health services and a 0 percent rate for inpatient services; out-of-pocket expenses were limited to $150 per person annually (or $450 per family). In effect, this plan had an individual deductible for outpatient care. All plans covered a broad range of medical and dental benefits, including all dental services other than orthodontic treatment with fixed appliances. Families obtained dental care from the practitioners of their choice. Further details about the insurance plans are provided elsewhere (see Clasquin and Brown, 1977).

The assignment process used a variant of random sampling that made the distribution of family characteristics as similar as possible across plans (Morris, 1979; see also Table 1 in Bailit et al., 1985). Approximately 70 percent of families were randomly assigned to a three-year term of participation; the remaining 30 percent were assigned a five-year term.

II. EXPLAINING ADULTS' USE OF DENTAL SERVICES: SELECTING IMPORTANT EXPLANATORY VARIABLES

RATIONALE

As we noted in the Introduction, previous analyses of dental utilization behavior have left us with several questions regarding the factors that explain use and nonuse of different types of services. With some exceptions, earlier analyses of dental utilization behavior emphasized sociodemographic characteristics and dental insurance status as key explanatory variables (Manning et al., 1985, 1986; Manning and Phelps, 1978a, 1978b; Phelps and Newhouse, 1974; Rossiter, 1982). In addition to these variables, other studies of dental utilization (e.g., Haefner, 1974; Holtmann and Olsen, 1976; Kegeles, 1963a,b; Newman and Anderson, 1972) and theoretical models of utilization (Andersen and Newman, 1973; McKinlay, 1972) identify several more explanatory factors that deserve consideration, including oral health status, such psychological variables as satisfaction with dental care, continuity of care, and community characteristics. Moreover, most research on dental utilization examined utilization in the aggregate (Bloom, 1982; Evashwick, Conrad, and Lee, 1982; Givens, 1979; Jack and Ries, 1981; Newman and Anderson, 1972; Newman and Larsen, 1980; Trevino and Moss, 1984; Wilder, 1984) rather than differentiating the various types of use (e.g., preventive, illness-related, as in Newman and Anderson, 1972). As Wan and Yates (1975) have noted, there are both theoretical (cf. the Health Belief Model, Rosenstock, 1966) and empirical reasons to believe that differing factors will explain use of different types of services.

Given the comprehensive set of explanatory variables available to us from the HIE database, we were able to consider these other explanatory factors in modeling adults' use of dental services. The availability of detailed claims data allowed us to distinguish the two components of utilization (probability of use and level of use given that use occurred) as well as preventive and illness-related services.

The analyses reported here were designed to:

- Identify which among multiple measures of each explanatory category provide the most explanatory power to models of adults' utilization, and

- Examine whether conclusions regarding the definition of explanatory factors depend on the definition of utilization considered.

Although most of these analyses consider the explanatory categories separately, we also take a brief look at the variables that best explain probability of use and per-user expenditures when the explanatory categories are considered together.

METHODS

Analytic Sample

Our analytic sample included adult enrollees ages 14 through 62 who were eligible for insurance benefits during the entire second year of the experiment.[1] To ensure greater generalization of our results, we were interested in explaining "steady-state" utilization rather than the transitory response to dental insurance coverage observed during the first year (Manning et al., 1985, 1986). Studying utilization during the second year avoided this transitory surge in demand. We excluded adults who had dropped out of the study or had been terminated administratively and those who were eligible for partial-year coverage from our analyses.[2]

The analytic sample numbered 3705 adults. Table 1 presents information on selected sociodemographic and other characteristics of the sample, across sites and in each site. The sample averaged 33 years of age, was split roughly evenly between women and men, and the average person had a high-school education. Family income averaged $22,164 (in 1983 dollars). About 15 percent of the sample was nonwhite; most of this group resided in the two South Carolina sites. Just over 60 percent of the adults were employed, and a similar percentage were married; the average family had three members. Some 6 percent of families were receiving Aid to Families with Dependent Children (AFDC Medicaid) at the study's outset. In terms of experimental variables,

[1]Section IV reports results from analyses of utilization for those younger than 14 years of age.

[2]Dropouts accounted for most of the sample loss, and virtually all such attrition occurred during the study's first year. Given the large transitory surge in demand for dental services observed during the first year of experimental insurance coverage (Manning et al., 1985, 1986), we did not have enough precision to detect any differences in dental utilization between dropouts and those remaining in the analytic sample (Manning, personal communication). We do know that this attrition did not bias analyses of medical care expenditures (Manning et al., in press).

Table 1

SELECTED CHARACTERISTICS OF ADULT ANALYTIC SAMPLE, ACROSS SITES AND BY SITE
(Standard errors in parentheses)

Characteristics	Combined Sites	Seattle	Massa-chusetts	South Carolina
Sample Size				
Individuals	3705	1548	1031	1126
Families	1954	869	544	541
Sociodemographics				
Age (years)	33.0	32.8	33.6	32.8
	(.21)	(.31)	(.40)	(.39)
Male (%)	46.4	48.3	46.4	44.0
	(.01)	(.01)	(.02)	(.01)
Education (yrs)	12.1	12.9	12.3	10.8
	(.05)	(.06)	(.08)	(.01)
Income ($)[a]	22,164	23,658	19,772	18,859
	(303)	(436)	(504)	(486)
Black (%)[a]	14.7	5.2	1.7	43.8
	(.01)	(.01)	(.01)	(.02)
Employed (%)	63.4	62.7	63.8	64.0
	(.01)	(.01)	(.02)	(.02)
Married (%)	62.4	62.2	64.8	60.5
	(.01)	(.01)	(.01)	(.01)
Family size[a]	2.9	2.6	2.9	3.3
	(.03)	(.05)	(.07)	(.08)
Previous Insurance Coverage				
AFDC (%)[a]	6.2	5.4	8.0	6.2
	(.003)	(.02)	(.01)	(.01)
Experimental Variables				
3-year sample (%)	69.7	62.7	76.4	74.6
	(.01)	(.02)	(.02)	(.02)
Enrollment physical (%)	59	50	74	59

[a]These variables were measured, and statistics calculated, at the family level; all other variables were measured and statistics calculated at the person level.

almost 70 percent of this sample (as in the entire study) had been assigned to a three-year term of participation, and a 59 percent random sample had received a clinical examination at enrollment.

Because the sample of adults was large enough, we divided it randomly into an exploratory sample (n = 1913) for model-fitting and a confirmatory sample (n = 1792) for cross-validation of results.[3] We tested for and found no significant differences in the characteristics of these subsamples (see App. Table A.1).

Data Collection

Among the explanatory variables, data on most sociodemographic characteristics were obtained at or before enrollment. Data on family income were obtained during the experiment's first year. A randomly selected 59 percent of adults received an enrollment examination, which provided clinical assessments of oral health status. Data for all other explanatory variables came from self-administered questionnaires fielded at the outset of the second experimental year. Utilization variables were calculated from claims submitted throughout each participant's second year.

Dependent Variables

We defined six dependent variables, three measures of the propensity to use dental services and three measures of the intensity of use. The measures included:

- Probability of using preventive dental services (prophylaxis and/or dental examinations);
- Expenditures on preventive dental services, for users;
- Probability of using illness-related services (extractions, endodontia, periodontia, restorations, or other nonpreventive procedures);
- Expenditures on illness-related services, for users;
- Probability of using any dental services; and
- Expenditures on all dental services used, for users.

Using the American Dental Association's (1972) 10-category service classification, codes on claim forms were used to distinguish preventive

[3]We used the SAS RANUNI function to generate the two analysis samples; the sampling fraction specified (0.5) actually yielded an exploratory sample somewhat larger than half.

and illness-related services. The probability definitions were dichotomous (0,1) variables, with "1" indicating the individual made at least one visit for a given type of service during the year. The expenditure definitions were expressed as the log of the dollars spent on dental services and were computed only for those who made at least one visit during the year for a given type of service.[4] Unlike counts of visits, expenditures reflect the amount, intensity, and quality of services used. The log transformation reduced the skewness in the distribution of dental expenditures, thereby minimizing the influence of large users on our conclusions.

Descriptive statistics for the utilization measures appear in App. Table A.1. During the year, 59 percent made one or more dental visits, 53 percent received preventive services, and 44 percent obtained illness-related dental care. Preventive services accounted for much of the probability of any use, while the illness-related services accounted for the majority of total dental expenditures for those who used care.

Explanatory Variables

Based on both theory and content analyses, we grouped measures of the explanatory variables into six categories:

- Oral health status,
- General health perceptions,
- Satisfaction with dental care,
- Health-related beliefs, knowledge, and other attitudes,
- Continuity of dental care, and
- Sociodemographics.

All but continuity of dental care were represented by several variables in the HIE database. Variables in the oral health, dental satisfaction, and continuity categories referred specifically to dental health and dental care. Variables in the other categories referred to health more generically (general health perceptions) or to beliefs, knowledge, and attitudes about medical care or health care in general.[5]

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[4]These definitions were calculated at the service, rather than visit, level, because a single visit could include both preventive and illness-related services. In such a case, the individual received a score of "1" for each probability definition; actual expenditures were allocated to preventive or illness-related services according to the classification scheme.

[5]Further information on the scoring, reliability, and validity of the explanatory variables in the HIE database is available elsewhere. For oral health status, see Smith et al. (1978) and Spolsky et al. (1983); general health perceptions (Davies and Ware, 1981; Ware, 1976; Ware et al., 1978); satisfaction with dental care and continuity of dental care (Davies and Ware, 1982); and health-related beliefs, knowledge, and attitudes (Lau and Ware, 1981; Newhouse, Donald, and Ware, 1981).

Table 2 identifies the variables in each of the six categories and notes the meaning of higher scores on each. For the health status, satisfaction, and other attitudinal variables, Table 2 indicates the direction of scoring—whether a higher score indicates better (+) or worse (−) health status,[6] or favorable (+) or unfavorable (−) attitudes. Dummy variables were scored so that "1" represents the variable name.

Descriptive statistics for the explanatory variables used in analyses of adult's utilization appear in App. Table A.1.

Hypotheses

We began with several hypotheses regarding reasons for nonuse and low expenditures by users of dental services that we derived from reviews of the dental and medical literature. All hypotheses pertain to explanation of annual, rather than life-time, utilization, and to the relationship between a single explanatory category and utilization all other factors held constant. In particular, we posited the following:

- *Those in poorer oral health are less likely to use services, while those in better oral health spend less when they use.* Findings from earlier studies prove inconsistent regarding the relationship of oral health status to probability of use. The directionality of this association may relate in part to whether the oral health assessment comes from self-report (better oral health associated with smaller likelihood of use, as reported by Newman and Anderson, 1972) or clinical examination (poorer oral health associated with lower rates of use, as reported by Freeman and Lambert, 1965, and Tyroler et al., 1965). To the extent that current oral health status reflects previous use, findings from earlier studies suggest that those currently in good oral health have used dental services and will continue to use them, and that those in poor oral health will be less likely to use in the future (e.g., Newman and Anderson, 1972).
- *Those who have favorable perceptions of their health in general are less likely to use services and spend less when they use.* To our knowledge, no previous research has studied the

[6]In the case of DMF28_F, the count of filled teeth, whether a higher count indicates better or worse oral health status (or lesser or greater need) is somewhat ambiguous, because it depends on the scores for the other components of this index. Assuming few decayed or missing teeth, those with fewer filled teeth are in better oral health than one with more filled teeth. About persons with few decayed or missing and several filled teeth, we know they were in poor oral health in the past, obtained services, and are probably in better current oral health status than those with many unfilled teeth.

Table 2

OPERATIONAL DEFINITIONS AND DIRECTION OF SCORING FOR EXPLANATORY VARIABLES, BY CATEGORY, ADULT UTILIZATION ANALYSES

Explanatory Category/Variable	Direction[a]	Definition
Oral Health Status		
Clinically Assessed		
DMF28_D	–	Count of decayed permanent teeth (based on 28)
DMF28_M	–	Count of missing permanent teeth (based on 28)
DMF28_F	?	Count of filled permanent teeth (based on 28)
Oral Hygiene Index	+	Continuous; higher scores indicate better oral hygiene
Periodontal Index	–	Continuous; higher scores indicate poorer periodontal health
Oral health, year 2	–	Categorical; higher scores indicate greater need for dental care during year under study
Common Self-Report Measures		
Bleeding gums	–	Dummy; 1 = reported bleeding gums in past 30 days
Toothache	–	Dummy; 1 = reported toothache in past 30 days
Other Self-Report Measures		
Need cleaning	–	Continuous; higher score indicates greater perceived need for cleaning
Impact of disease	–	Continuous; higher score indicates greater pain, more worry, and avoidance of conversation due to dental problems
General Health Perceptions		
Current Health	+	Continuous; higher score indicates more favorable ratings of current health
Prior Health	+	Continuous; higher score indicates more favorable ratings of health in the past
Health Outlook	+	Continuous; higher score indicates more favorable ratings of health in the future
Resistance to Illness	+	Continuous; higher score indicates more favorable ratings of resistance to illness

Table 2—continued

Explanatory Category/Variable	Direction[a]	Definition
Sickness Orientation	–	Continuous; higher score indicates perception that sickness is a part of life
Health Worry	–	Continuous; higher score indicates greater worry about health
Satisfaction with Dental Care		
Availability/Convenience	+	Continuous; higher score indicates more favorable attitudes toward the availability and convenience of dental services
Access	+	Continuous; higher score indicates more favorable attitudes toward the accessibility of dental care
Cost of Care	+	Continuous; higher score indicates more favorable attitudes toward the costs of dental services
Technical Quality	+	Continuous; higher score indicates more favorable attitudes toward the technical and interpersonal aspects of dental care
Pain Management	+	Continuous; higher score indicates more favorable attitudes toward the dentist's management of dental pain
General Satisfaction (residualized)	+	Continuous; higher score indicates greater satisfaction with those aspects of dental care not explained by scores on preceding satisfaction scales
Health-Related Beliefs, Knowledge, and Other Attitudes		
Efficacy of Self-Care	+	Continuous; higher score indicates greater belief in efficacy of self-care
Efficacy of Doctor's Care	+	Continuous; higher score indicates greater belief in efficacy of care provided by doctor
Doctor's Mistakes	+	Continuous; higher score indicates greater belief that doctors make mistakes
Belief in Role of Chance	+	Continuous; higher score indicates greater belief that chance plays role in health events
Consumer Sophistication	+	Continuous; higher score indicates greater knowledge about medical care system
Attitude Toward Going to the Doctor	+	Continuous; higher score indicates more favorable attitude toward going to the doctor

Table 2—continued

Explanatory Category/Variable	Direction[a]	*Definition*
Rejection of Patient Role	+	Continuous; higher score indicates greater rejection of sick role behavior
Health Concern	–	Continuous; higher score indicates greater concern about health
Continuity of Dental Care		
Continuity	+	Continuous; higher score indicates greater continuity of dental provider
Sociodemographics		
Gender		Dummy; 1 = female
Age	+	Continuous; age at outset of second experimental year
Family size	+	Continuous; number of people covered by experimental insurance policy
Ethnicity		Dummy; 1 = black
Family income	+	Continuous; income during experiment's second year
Missing income		Dummy; 1 = family income missing and replaced with predicted value
Site (Fitchburg, Franklin County, Charleston, Georgetown County)		Dummies; 1 = specified site; Seattle is the hold-out site
Plan (C025, C050, C095, ID)		Dummies; 1 = assigned to specified coinsurance rate or individual deductible (ID); Free is the hold-out plan
Education (Less than high school; some college; college graduate)		Dummies; 1 = educational attainment as specified; high school graduate is the hold-out group
AFDC		Dummy; 1 = family receiving AFDC at enrollment
Missing AFDC		Dummy; 1 = AFDC data missing
Marital status		Dummy; 1 = married
Employment status		Dummy; 1 = employed

[a]Direction indicates whether higher score on variable represents better (+) or worse (–) health, in the case of the Oral Health Status and General Health Perceptions categories; favorable (+) or unfavorable (–) attitudes and beliefs, in the case of the Dental Satisfaction and Health-Related Beliefs, Knowledge, and Attitudes. In the case of DMF28_F, the direction of scoring is unclear because this variable reflects more than oral health status (see text).

relationship between general health perceptions and either use of dental services or oral health status. To the extent that better perceived health reflects better self-assessed oral health, we expect a negative relationship between general health perceptions and dental use (as above). If similar models explain both dental and medical care utilization, we would expect a negative relationship on the basis of research on general health perceptions and medical care utilization (e.g., Manning, Newhouse, and Ware, 1982).

- *Those who are less satisfied with their dental care providers are less likely to use dental services and probably spend less when they do use.* The expectation of a positive relationship between satisfaction and probability of dental use carries both intuitive appeal and the support of empirical results, albeit results from "postdictive" studies (e.g., Bene, Novasky, and Geldart, 1974; Murray and Wiese, 1975; Stacey, Slome, and Musgrave, 1978). The relationship between satisfaction and expenditures has received little attention. We expect, however, that if attitudes toward dental care services and providers influence willingness to comply with recommended utilization once in the system, all other things equal, those who are less satisfied will be less likely to comply and thus will spend less.
- *Individuals with unfavorable health-related beliefs and attitudes, and who are less sophisticated about the medical care system, are less likely to use dental services and spend less when they use.* Most of the data available on the relationship between dental health-related beliefs, attitudes, and knowledge and dental utilization come from studies of the Health Belief Model (e.g., Haefner, 1974; Kegeles, 1963a,b), and results are inconclusive. When these factors do have significant effects on utilization, they tend to be negative, hence our hypothesis. Again, if similar factors explain medical and dental expenditures, we would also expect a negative relationship (Manning, Newhouse, and Ware, 1982, p. 86).
- *Individuals with greater continuity of dental provider will be more likely to use dental services.* Definitions of continuity reflect, to a greater or lesser extent, past utilization; in at least one study (Newman and Anderson, 1972), continuity and previous use were synonymous. If those with more continuity are more likely to have used dental services in the past, they are also more likely to use such services in the future. The theoretical relationship between continuity and expenditures is less clear, therefore we did not outline a directional hypothesis. To

the extent that continuity of provider indicates a better relationship with the provider, theory regarding doctor-patient relationships and compliance (DiMatteo and DiNicola, 1982) suggests that those with greater continuity would be more likely to follow prescribed treatment plans once they obtain care, and thus may spend more on care. Continuity of provider may, however, lead to better oral health status, which could mean fewer and less expensive services for users.

Analytic Methods

Our work on the models of utilization progressed through several steps. Bivariate analyses documented the zero-order relationships among explanatory variables and between these variables and the different definitions of utilization. These results provided useful background information for the multivariate analyses. They also allowed us to examine many relationships that had not been estimated previously (e.g., whether people consider their oral health when evaluating their health in general; whether satisfaction with dental care is related to utilization).

We did multivariate analyses within each of the independent variable categories to identify the subset of measures that best represented that category in explanatory models of dental utilization. Having identified the best definition of each category in our dataset, we then tested models that provided information about the relative contribution of each variable to the propensity and intensity definitions of use. Throughout the analyses in the exploratory sample, we used fairly generous significance-testing criteria. Because many of the relationships we were studying had received little attention, we wanted to err on the side of overincluding variables to represent each explanatory category. We discuss below the specific analytic techniques used at each stage.

Bivariate Analyses. As appropriate, we computed Pearson product-moment correlations or point-biserial correlations; all of the available sample was used to estimate each relationship. In some cases, we also examined cross-tabulations for pairs of categorical variables.

Examination of relationships among variables within explanatory categories focused on the oral health measures. Earlier studies of HIE data had provided information about relationships among variables within other categories (Davies and Ware, 1981, 1982; Newhouse, Donald, and Ware, 1981; Ware et al., 1981). Across the categories of independent variables, we also examined relationships of which we had little knowledge: those between oral health and both general health

perceptions and satisfaction with dental care, and those between dental satisfaction and both general health and health-related beliefs, knowledge, and attitudes. Finally, we estimated correlations between all definitions of utilization and all explanatory variables.

Choosing Variables to Represent Each Explanatory Category. To identify the subset of variables that best represented each explanatory category in models of dental use, we used both "build-up" and "build-down" techniques in analyses of the exploratory sample.[7] As a general rule, we retained variables that passed both tests. These analyses were done separately for each of the six dependent variables. Once we had identified the "best" subset of variables in each explanatory category, we cross-validated our results in the confirmatory subsample.

The initial analyses relied on ordinary least-squares (OLS) techniques. Although OLS regression yielded biased parameter estimates for the probability equations, it provided approximately correct inferences about relationships between explanatory variables and the probability of use. The results reported here were based on final maximum likelihood logistic regressions (for the probability of use) and OLS (for expenditures), which yielded consistent parameter estimates and test statistics.

Build-Up Analyses. To begin these analyses, we first selected a core subset of variables within each category. They were chosen on the basis of their performance in a regression that used all measures in the category to predict each dependent variable. We then obtained OLS estimates for the core variables in the prediction of each dependent variable.

Next, each of the remaining variables in the category was added to the core set individually, then two at a time, three at a time, etc.; the final model included all measures in the category. Incremental F-statistics were computed at each step to determine the explanatory value (in statistical terms) of adding different combinations of remaining variables to the core set.

There were two exceptions to this strategy. First, we decided to examine the clinically assessed and self-report oral health variables separately because we had clinically assessed variables only for a random subset of the sample; combining them at this stage would have

[7]Build-down or stepwise regression analyses are commonly used for this purpose. Multicollinearity, however, can lead to the incorrect inference that a variable is insignificant in build-down analyses. Because we preferred to err on the side of *including* variables, we also used build-up techniques. The latter are unaffected by multicollinearity but may result in inclusion of an insignificant variable if omitted variables are correlated both with the dependent variable and the explanatory variable in question. The "truth" lies somewhere between the answers provided by each technique.

significantly reduced our sample size. We also wanted to distinguish the explanatory contributions made by the self-report measures, and by the clinical assessments, which are considerably more expensive to collect. We further divided the self-report measures into those that are traditionally obtained on dental surveys (bleeding gums, toothache), and the less common measures obtained by the HIE (need cleaning, impact of disease). (See Table 2 for further detail on these measures.) We did build-up and build-down analyses for the clinically assessed oral health measures, and included the four self-report measures *a priori*.

The second exception involved the sociodemographic set. To maintain comparability with our previous work on dental utilization, we included the experimental design variables (plan, site) in our models *a priori*, along with measures of all the other sociodemographic characteristics that had been used in earlier HIE analyses of the effects of cost-sharing on dental utilization (Manning et al., 1985, 1986). Thus, only four variables (employed, married, on AFDC at enrollment, missing AFDC data) were candidates for addition or exclusion.

During preliminary analyses, we also tested the usefulness of single- vs. multiple-measure specifications of two explanatory categories. For general health perceptions and for satisfaction with dental care, the database included subscales and indexes that summarized the subscales in a single score. In each case, the subscales provided more explanatory power than did the summary index, and we used the subscales in the build-up and build-down analyses.

Build-Down Analyses. We began these analyses with a model that included all of the independent variables in a given category. We then ran a series of regressions, each excluding one variable from the category. Comparison of the F-statistics for the first and subsequent regressions indicated the incremental explanatory power of the excluded variable. A separate series of regressions was done for each category and each dependent variable.

Based on results from the build-up and build-down analyses, we selected the measures that best represented each independent variable category. Specifically, the measures we retained on the basis of these exploratory analyses generally yielded significant ($t \geqq |1.414|$, $p \leqq 0.15$) (Mallows, 1973) and stable parameter estimates in build-up analyses or significant incremental validity in the build-down analyses. We allowed the definition of each explanatory category (in terms of retained variables) to vary between the probability and expenditures equations. We retained the same variables within each explanatory category for all three probability equations; similarly, we kept the same variables in each category for the three expenditures equations.

During these analyses, independent variables were entered in linear form. Once we had identified the best subset of variables in each category, we checked the appropriateness of the linear specification by using alternative transformations (log, inverse, and square root) of each explanatory measure, as well as by testing the overall fit of the model using a variant of Pregibon's (1979) goodness-of-fit/linearity test.

For all explanatory categories in all equations, except satisfaction with dental care in probability equations, we were unable to improve over untransformed specifications. Significant nonlinearity was reduced (but not entirely eliminated) for the dental satisfaction set by adding the interaction of Availability/Convenience and Pain Management, and by replacing Access with its square. We also examined several policy-relevant interactions (e.g., insurance plan by oral health status, oral health status by satisfaction with dental care); none contributed significantly to our explanatory models.

Cross-Validation. After completing model-fitting analyses for each explanatory category in the exploratory sample, we cross-validated the sets of retained and of excluded variables in the confirmatory sample. To determine whether our conclusions regarding the "best" (retained) subset of variables in each explanatory category replicated in the second half of the sample, we also used the Wald test to evaluate whether the estimated difference in the response (including the intercept) across the two samples was statistically different from zero. We used a Bonferonni-bound correction to adjust p-values of the χ^2-statistics to account for multiple comparisons (one for each category of the independent variables with each of six dependent variables).

Differences Between Probability and Expenditure Models. To further examine the importance of individual variables to explaining probability of use and expenditures by users, we tested a model that included measures from all explanatory categories to predict *both* components of utilization (the probability and expenditures equations). Using the best subset of measures from all categories, we estimated both the probability of any dental use and per-user expenditures on all dental services. We then calculated the expected per-person expenditures on dental services by combining results from the two equations. Unlike some models of use, this two-part model did not require normal or multivariate normal assumptions (Heckman, 1979; Van den Ven and Van Praag, 1981). (For further details on the two-part model, see Duan, 1982, 1983, or Manning et al., 1986, App. B.) Results from the two-part model were interpreted to indicate whether the variable contributed more to explaining the probability of use or per-user expenditures, and the net effect of the variable on per-person expenditures.

RESULTS

Variables that Best Represent the Explanatory Categories

The data in Table 3 summarize the detailed results reported in App. Tables A.2 through A.7.[8] Entries in Table 3 indicate the direction (+ positive or − negative) of significant ($p < 0.05$) bivariate relationships for all explanatory variables and each definition of utilization (see cols. headed "Bivariate"). Entries also indicate the direction of significant relationships from multivariate analyses for those variables that were retained after the build-up and build-down analyses (see cols. headed "Multivariate"). Variables in each category that we retained for the probability definitions are marked *, and for the expenditure definitions, †. An S indicates that the set of retained variables in the category was significantly ($p < 0.10$) related to the dependent utilization variable. The multivariate results summarized in Table 3 were the significant ($t \geqq 1.64$, one-tailed test) relationships observed in the *confirmatory* sample.

Below, we comment on these results category by category. Given our substantive interest in the variables that explain nonuse, our comments for the probability equations emphasize relationships that are *opposite* those shown in Table 3 (because the dependent dichotomous variables were actually scored to indicate use). We note those instances where relationships observed in bivariate analyses changed when we considered multiple measures in each category, and we comment on differences in the best definition of each category for the probability of using dental care compared with expenditures on dental services by users. Given relationships among the dependent variables, we remind the reader that the results for the three use/nonuse definitions are not independent, nor are those for the three expenditure definitions. To reiterate, the probability of preventive use accounted in large part for the probability of any use, and expenditures on illness-related services accounted for the majority of total user expenditures.

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[8]Appendix Tables A.2 through A.7 report results from bivariate and multivariate analyses designed to identify the subset of variables that best represented each explanatory category in analyses of the six definitions of adults' dental utilization. Results for the probability definitions appear in Tables A.2 through A.4, and for expenditures by users, in Tables A.5 through A.7.

Table 3

SUMMARY OF RESULTS: VARIABLES THAT BEST REPRESENT EXPLANATORY CATEGORIES IN ANALYSES OF ADULTS' UTILIZATION[a]

Explanatory Category/Variable	Bivariate						Multivariate					
	Probability			Expenditures			Probability			Expenditures		
	P	I	T[b]	P	I	T	P	I	T	P	I	T
Oral Health Status												
Clinically Assessed							S	S	S		S	S
DMF28_D*†	–		–		+	+					+	+
DMF28_M*†	–	–	–		+	+		+			+	+
DMF28_F*†	+	+	+	+			+	+	+		+	+
Periodontal Index*†	–	–	–	+	+	+				+		+
Oral health, year 2*†	–	–	–		+	+	–	–	–			
Oral Hygiene Index	–	–	–		+	+						
Common Self-Report Measures							S	S	S		S	S
Bleeding gums*†	–		–		+	+	–	–	–		+	+
Toothache*†		+					–				–	
Other Self-Report Measures							S		S		S	S
Need cleaning*†	–		–	+	+	+	–	–	–			
Impact of disease*†		+		+	+	+				+	+	+
General Health Perceptions							S				S	S
Current health*	+		+		–							
Prior health												
Health outlook*†	+		+				+		+			
Resistance to illness*†												
Sickness orientation			–									
Health worry†	–		–		+						+	+
Satisfaction with Dental Care							S	S	S		S	S
Availability/Convenience*	+	+	+									
Access*	+	+	+	+	–	+	+	+	+			
Costs of Care†	+	+	+		–						–	
Pain Management*†	+	+	+		–							–
Technical Quality	+	+	+	+		+						
General Satisfaction*†	+	+	+		–	–	+		+		–	–
Health-Related Beliefs, Knowledge, and Other Attitudes							S	S	S			
Efficacy of self-care*†	–	–	–	–			–	–	–			
Efficacy of doctor's care*†				–			–		–			
Doctor's mistakes*†	–		–									
Belief in role of chance	–	–	–									
Attitude toward going to doctor*		+	+				+	+	+			
Rejection of patient role						+						

Table 3—continued

Explanatory Category/Variable	Bivariate						Multivariate					
	Probability			Expenditures			Probability			Expenditures		
	P	I	T[b]	P	I	T	P	I	T	P	I	T
Consumer sophistication			+									
Health concern	−		−	−								
Continuity of Care												
Continuity of Dental Care*	+	+	+			−						
Sociodemographics							S	S	S	S	S	S
Age*†					+	+	−				+	+
Gender (female)*†							+		+			
Ethnicity (black)*†	−	−	−		+	+	−		−			
Less than high school*†	−	−	−	−		+	−		−			
Some college*†	+	+										
College graduate*†	+		+			−	+	+	+			
Family income*†	+	+	+	−			+		+		−	−
Missing income*†	−	−	−						−	−		
Family size*†	−	−	−	−						−	+	
Coinsurance 25%*†							−		−			
Coinsurance 50%*†	−	−	−	−	−	−	−	−	−			−
Coinsurance 95%*†	−	−	−	−		−	−	−	−		−	
Individual deductible*†	−	−					−	−	−	−	−	−
Fitchburg*†		+		−	−	−				−	−	−
Franklin County*†	+	+	+	−	−	−	+		+	−	−	−
Charleston*†	−	−	−					−		−		
Georgetown County*†	−	−	−	−						−		−
Married		+	+									
Employed												
AFDC	−											
Missing AFDC												

[a]Key to table entries:

S indicates the subset of variables best representing the explanatory category was significant in explaining utilization definition.

\+ indicates the variable defined in that row had a significant and positive relationship with the utilization definition.

− indicates the variable defined in that row had a significant and negative relationship with the utilization definition.

* indicates the variable was retained to define the category in explaining probability definitions.

† indicates the variable was retained to define the category in explaining expenditure definitions.

[b] P = preventive services.
I = illness-related services.
T = total services (preventive plus illness-related).

Oral Health Status

In bivariate analyses, all but one of the clinically assessed oral health measures was significantly related to the probability of use (see App. Tables A.2 through A.4). The exception was that the number of decayed teeth was unrelated to probability of illness-related use (see App. Table A.3). All but the number of filled teeth were significantly related to total expenditures by users. Only the number of filled teeth and the Periodontal Index were significantly related to expenditures on preventive care by users (see App. Table A.5).

In bivariate analyses, those oral health status variables that predicted nonuse tended to predict greater expenditures by users; by contrast, those that predicted use tended to relate to fewer expenditures by users. Adults with more decayed, more missing, and fewer filled teeth were generally less likely to get dental care. Those judged to be in need of dental care at the outset of the second year were less likely to obtain services of any type. Those who reported bleeding gums during the past 30 days and who indicated they needed cleaning were less likely to use preventive services (and thus to use any dental care). Although these two self-report measures were unrelated to likelihood of illness-related services, we found that those who reported no toothaches during the past 30 days and those who were less affected by oral disease were less likely to obtain such services.

Also in bivariate analyses, users with more decayed and missing teeth and in worse periodontal health spent more on dental care, particularly on illness-related services. Similarly, users who reported worse oral health habits, toothaches during the past 30 days, greater perceived need for cleaning, and greater impact from oral health problems spent more on dental care. The number of filled teeth (which reflects poor oral health in the past and previous use of dental services) was significantly and positively related only to user expenditures on preventive dental care.

In multivariate analyses, all but one of the clinically assessed measures (Oral Hygiene Index) was retained to explain both probability of use and expenditures by users. As noted earlier, we included the common survey and other self-report oral health status measures *a priori*. The retained oral health status measures were significantly related to all definitions of utilization except expenditures on preventive dental care by users (see App. Table A.5). In addition, the other self-report measures (need cleaning, impact of disease) were unrelated to the probability of illness-related use (see App. Table A.3).

Multivariate relationships generally confirmed those observed in bivariate studies, but we noted one reversal. Bivariate analyses

indicated that those with more missing teeth were *less* likely to obtain illness-related care; when relationships among the oral health status measures were taken into account, those with more missing teeth were *more* likely to use such services (see App. Table A.3).

General Health Perceptions

Among the general health perceptions variables, most of the significant bivariate relationships we observed were with the probability of preventive care and any dental care (see App. Tables A.2 and A.4). Those currently in poor health, with a less favorable outlook on future health, and who worried more about their overall health were less likely to use preventive services. In bivariate analyses, these measures were unrelated to probability of illness-related services (see App. Table A.3). Only two of the general health measures were related to expenditures; users who perceived themselves in better current health and who worried less about their overall health spent less on illness-related dental services (see App. Table A.6).

Current Health, Health Outlook, and Resistance to Illness were retained on the basis of build-up and build-down analyses to define the general health perceptions category for the probability definitions. This set was significantly related to probability of using any dental care, in large part because those with less favorable perceptions of their future health were less likely to obtain preventive services (see App. Tables A.4 and A.2).

Health Outlook and Resistance to Illness, along with Health Worry, were retained to predict expenditures by users. This set was significantly related to total expenditures by users, chiefly because of the relationship between health-related worry and illness-related expenditures; users who reported less worry spent less (see App. Tables A.7 and A.6).

Satisfaction with Dental Care

Bivariate analyses indicated that satisfaction with all aspects of dental care was significantly related to the probability of using dental care of all types (see App. Tables A.2-A.4). Those who were less satisfied were less likely to use services.

Results from bivariate analyses presented a less clear picture of the relationship between satisfaction and expenditures, because they appeared to differ by service type. Attitudes toward accessibility and technical quality were significantly and positively related to total expenditures and to expenditures on preventive services (see App.

Tables A.7 and A.5). By contrast, those who were more satisfied in general spent less on all dental care; those who were more satisfied with access, cost, pain management, and overall spent less on illness-related dental services.

Availability/Convenience, Access (squared, see Table 2), Pain Management, and General Satisfaction (residualized, see Table 2) were retained to explain the probability of using dental services. This set was significantly related to the probability of using dental services of all types; unfavorable attitudes toward access accounted in large part for a decreased likelihood of using dental care (see App. Tables A.2-A.4).

We retained Pain Management, Costs of Care, and General Satisfaction (residualized, see Table 2) to define the dental satisfaction category in predicting expenditures by users. This set was significantly related to illness-related and thus to total expenditures (see App. Tables A.6 and A.7). As in bivariate analyses, users who were more satisfied in general and with costs of dental care spent *less* on illness care (see App. Table A.6).

When correlations among the dental satisfaction measures were taken into account, attitudes toward technical quality of dental care did not contribute significantly to explaining utilization of any type.

Health-Related Beliefs, Knowledge, and Other Attitudes

Most of the significant bivariate relationships we observed for measures of health-related beliefs, knowledge, and other attitudes were with the probability of getting care (see App. Tables A.2-A.4). Those with more negative beliefs about providers (e.g., who believe that providers often make mistakes and that chance plays a major role in determining health) and who believed more in the efficacy of self-care were less likely to use dental services, as were those who were more concerned about their health. Those who were less knowledgeable about the medical care system were also significantly less likely to use dental care.

Only three variables in this category were significantly associated with expenditures on preventive dental services, and only one with total expenditures by users in bivariate analyses. Users who believed more in the efficacy of self-care and of doctor's care spent less on preventive services (see App. Table A.5). Users who tended to accept the sick role also spent less on all dental care (see App. Table A.7).

Efficacy of Self-Care and of Doctor's Care, as well as Doctor's Mistakes and Attitude Toward Going to the Doctor were retained to explain the probability of dental care; all but the latter were retained to

explain dental expenditures by users. The retained variables were significantly related only to the probability of using dental care (see App. Tables A.2 through A.4). Those who believed *more* in the efficacy of self-care and of doctor's care were less likely to use dental services, as were those with less positive attitudes toward going to the doctor.

Continuity[9]

Those with less provider continuity were significantly less likely to use dental care. Although unrelated to expenditures on preventive or illness-related services, continuity was significantly and negatively related to total expenditures by users; those reporting greater continuity spent less on care.

Sociodemographics

In bivariate analyses, virtually all sociodemographic variables *except* age, gender, and marital and employment status were significantly related to the probability of using dental services (see App. Tables A.2-A.4). Blacks, those with lower incomes, and those in larger families were less likely to use dental services, as were the less well-educated.

Still considering bivariate analyses, fewer of the sociodemographic characteristics were related to expenditures by users (see App. Tables A.5-A.7). Younger and nonblack users spent less on all dental care; in both cases, the relationship was accounted for largely by their lower expenditures on illness-related services. Those with more education also spent significantly less.

The sociodemographic variables we tested in the build-up/build-down analyses (marital status, employment status, whether any member of the family was receiving AFDC) rarely correlated significantly with dental utilization variables in bivariate analyses. Multivariate analyses similarly concluded that they were unimportant explanatory measures, and they were not retained to define this category.

The set of sociodemographic measures we retained was significantly related to *all* definitions of dental utilization. As in the bivariate analyses, more sociodemographic variables were significantly related to probability of use than to expenditures by users when relationships among these characteristics were considered. We observed no reversals of relationships from bivariate to multivariate analyses, but the

[9]The HIE data included only one measure of continuity; thus, build-up and build-down analyses were not done.

explanatory power of some sociodemographic variables increased and others decreased. For example, age and gender were significantly related to probability of use in multivariate analyses; younger people and men were less likely to use dental services, particularly preventive services (see App. Tables A.2 and A.4). In multivariate analyses of expenditures, only age and family income, among the traditional sociodemographic measures, were significant. The effects of ethnicity, education, and family size tended to disappear (see App. Tables A.5-A.7).

As has been reported previously, the experimental design variables also correlated with dental utilization (Manning et al., 1985, 1986). Bivariate analyses indicated that those assigned to cost-sharing plans (with the exception of the 25 percent plan) were significantly less likely to use care of all types and spent less on dental services than did those on the free plan. Seattle adults were significantly more likely to use care and spent more on dental services. Multivariate analyses indicated that coinsurance was more often related to probability of use than to expenditures by users; differences between sites diminished in multivariate analyses of probability of use but remained significant in explaining expenditures on dental care by users.

Cross-Validation

Cross-validation generally confirmed the results of our build-up and build-down analyses regarding the best explanatory variables in each category. In all probability equations, the variables we excluded from each of the explanatory categories made insignificant incremental contributions to variance explained in the exploratory sample (see App. Table A.8). On cross-validation, we noted three discrepancies. In the confirmatory sample (see App. Table A.9), we noted that the excluded oral health status measure (Oral Hygiene Index) made a significant increment in explaining probability of any use ($\chi^2_1 = 5.42$, $p < 0.05$) and of preventive use ($\chi^2_1 = 3.32$, $p < 0.10$). Similarly, the excluded health-related beliefs measures (Consumer Sophistication, Belief in the Role of Chance, Rejection of Patient Role, and Health Concern) added significantly as a set to the retained variables in explaining probability of any use ($\chi^2_4 = 8.24$, $p < 0.10$; see App. Table A.9).

In all but one expenditure equation for the exploratory subsample, excluded variables in each explanatory category added insignificantly to variance explained (see App. Table A.10). The one exception was the excluded general health perceptions measures (Current Health, Prior Health, and Sickness Orientation), which contributed significant incremental variance to the prediction of total expenditures for users

($F_{3,1080} = 2.28$, $p < 0.10$). (This finding clearly represents an error in the build-up/build-down analyses; see Sec. VI for discussion.) We observed a similar result in the confirmatory subsample (see App. Table A.11) for the excluded general health perceptions measures ($F_{3,1012} = 2.67$, $p < 0.05$). Also in the confirmatory subsample, the excluded oral health status measure (Oral Hygiene Index) and the excluded measures of satisfaction with dental care each made significant incremental contributions ($F_{1,495} = 5.51$, $p < 0.05$ and $F_{3,996} = 5.46$, $p < 0.001$, respectively; see App. Table A.11).

Results from our formal test of the similarity in coefficients for each set of retained explanatory variables appear in App. Table A.12. After adjusting the p-values for multiple comparisons, we found no significant ($p < 0.05$) differences between the coefficients for sets of retained variables in the exploratory and confirmatory samples.

Importance of Variables in Explaining Probability vs. Expenditures

Table 4 summarizes results from the two-part model of aggregate dental utilization. For each of the variables retained to define an explanatory category, Table 4 includes elasticity estimates[10] (and t-statistics) for the probability of any use, expenditures by users, and expenditures per person.[11] Results from the logistic and OLS regressions used to obtain these estimates appear in App. Tables A.13 and A.14.

Among the clinically assessed oral health variables, periodontal health status had significant and opposite effects on the two components of use. These opposing effects cancelled each other out in the explanation of per-person expenditures. The strong positive effect of a greater number of missing teeth on expenditures per user was also seen on per-person expenditures, despite a notable negative relationship with the probability of use. The significant negative effects on probability of use of both need for care at the outset of the year and perceived need for cleaning did not carry over to per-person expenditures because of noteworthy positive relationships between these explanatory

[10]The elasticity estimates indicate the percentage change in probability of receiving care, or in log dollars spent on dental care, for each 1 percent change in the explanatory variable at the mean. For example, Table 4 indicates that a 1 percent increase in family income at the mean is associated with a 0.2 percent increase in the probability of using dental care.

[11]Recall that the first (probability) equation was estimated for the entire sample; the second (expenditures, conditional on use), only for users. The two-part model produces estimates of expenditures per person, which are zero for nonusers. Thus, we distinguish between expenditures for users and expenditures per person.

Table 4

RESULTS FROM TWO-PART MODEL: PREDICTING ADULTS' DENTAL UTILIZATION

Explanatory Category/Variable	Probability		Expenditures Per User		Expenditures Per Person	
	E[a]	t[a]	E	t	E	t
Oral Health Status						
DMF28_D	0.06	2.15	0.17	3.68	0.23	4.26
DMF28_M	−0.05	−1.70	0.22	4.59	0.18	3.18
DMF28_F	0.08	2.51	0.63	7.48	0.71	7.88
Periodontal Index	−0.13	−1.81	0.30	1.99	0.17	1.01
Oral health, year 2	−0.05	−2.56	0.04	1.52	−0.01	−0.17
Toothache	−0.06	−1.01	−0.09	−0.79	−0.15	−1.17
Bleeding gums	−0.02	−1.08	0.03	0.95	0.01	0.26
Need cleaning	−0.07	−2.04	0.08	1.56	0.01	0.23
Impact of disease	0.10	1.62	0.16	1.12	0.27	1.68
General Health Perceptions						
Current Health	−0.18	−1.48	−0.05	−0.24	−0.23	−0.91
Health Outlook	0.13	1.14	0.27	1.30	0.40	1.68
Resistance to Illness	0.03	0.28	−0.28	−1.36	−0.25	−1.08
Health Worry	0.02	0.49	0.06	0.73	0.08	0.87
Satisfaction with Dental Care						
Availability/Convenience	−0.01	−0.07	0.34	0.76	0.33	0.67
Access	0.02	0.45	0.15	1.77	0.17	1.79
Pain Management	0.07	0.36	0.36	0.85	0.43	0.93
Availability × Pain	−0.01	−0.08	−0.49	−1.19	−0.50	−1.12
Cost of Care	−0.03	−0.71	−0.13	−1.32	−0.16	−1.49
General Satisfaction[b]	0.00	0.33	−0.00	−1.10	−0.00	−0.91
Health-Related Beliefs and Attitudes						
Efficacy of Self-Care	−0.17	−2.99	−0.09	−0.82	−0.26	−2.14
Efficacy of Doctor's Care	−0.28	−2.44	0.13	0.63	−0.15	−0.62
Doctor's Mistakes	−0.04	−0.58	0.11	0.83	0.08	0.46
Attitude Toward Going to Doctor	0.02	0.49	0.01	0.08	0.02	0.28
Continuity of Dental Care						
Continuity	0.20	3.20	−0.07	−0.46	0.13	0.75
Sociodemographics						
Age	0.16	2.31	−0.25	−1.72	−0.08	−0.52
Gender (female)	0.07	3.46	−0.09	−1.91	−0.02	−0.42
Ethnicity (black)	−0.01	−0.70	0.04	1.70	0.03	0.94

Table 4—continued

Explanatory Category/Variable	Probability		Expenditures Per User		Expenditures Per Person	
	E[a]	t[a]	E	t	E	t
Family size	0.01	0.21	−0.02	−0.18	−0.01	−0.06
Family income	0.20	4.53	0.07	0.73	0.27	2.68
Missing income	−0.00	−0.30	−0.01	−0.46	−0.01	−0.55
Less than high school	0.03	1.48	−0.01	−0.32	0.02	0.44
Some college	0.01	1.17	0.01	0.29	0.02	0.70
College graduate	0.02	2.90	−0.02	−1.05	−0.01	−0.29
Site	0.17	2.64	−0.04	−0.29	0.13	0.75
Coinsurance	−0.15	−4.49	−0.14	−2.99	−0.29	−5.06

[a]E = elasticity estimates; t = t-statistics.

[b]To four decimal places, the means are 0.0002, −0.0019, and −0.0017, respectively.

variables and per-user expenditures. Thus, although those who needed care were less likely to get into the system, those who did spent more on dental care.

Continuity of care and beliefs in the efficacy of doctor's care were significant only in explaining the probability of dental expenditures. The strong negative relationship between beliefs in the efficacy of self-care and probability of expenditures also appeared for total expenditures per person.

Gender had significant and opposite effects. All other things equal, men were significantly less likely to use dental services but spent more, so the net effect was trivial. Similarly, younger adults were less likely to use but spent more; again, the effect on expenditures per person was minimal. The effects of income and education (specifically, the contrast between college and high school graduates) were concentrated entirely on the probability of using care.

Summary

To summarize, we examine results from multivariate analyses in the confirmatory sample. Looking first at these results in terms of our hypotheses, we found that:

- For the clinically assessed oral health measures, our hypotheses were generally confirmed. Those in poorer health status were less likely to use dental services; when they did, they spent

more. Findings for the self-report oral health measures appeared to depend on the type of service and the measure considered. For preventive care, those who reported poorer health status (needed cleaning, had bleeding gums) were less likely to obtain services. For illness-related care, those who reported *better* health status (had toothaches, more impact of dental disease) were less likely to use such services.

- Findings regarding relationships between general health perceptions and utilization ran counter to our hypothesis. Those who reported themselves in poorer overall health status were *less* likely to use such services; we observed no association between perceived health and expenditures on dental care by users.
- We observed the expected association between satisfaction with dental care and probability of utilization. The less satisfied were less likely to obtain preventive (and therefore any) dental services. Findings regarding the association between satisfaction and expenditures ran counter to our hypothesis. Users who were more satisfied (particularly with costs, as well as care in general) spent *less* on illness-related care in the following year.
- Our hypothesis regarding the relationship for health-related attitudes, knowledge, and beliefs with utilization received weak support. The few measures in this category that were significantly associated with use explained probability of use; generally, those with less favorable beliefs and attitudes were less likely to obtain services.
- We confirmed the hypothesized association between continuity and probability of use; those with less provider continuity were less likely to use services of any type. Although not hypothesized, continuity was significantly related to total expenditures by users; we noted that users with less provider continuity spent more on all dental services.

When we consider the contribution of the explanatory categories separately, the preceding summary indicates that most categories were significantly associated with probability of use. Standing as exceptions to this pattern were the lack of significant associations between the less common self-report oral health measures (need cleaning, impact of disease) and probability of illness-related use, and between general health perceptions and probability of both illness-related and any use. All but two explanatory categories were significantly related to expenditures by users; those that were significant explained expenditures on illness-related (and thus total) but not preventive services. Unrelated

to expenditures were the general health perceptions and health-related beliefs, knowledge, and other attitudes categories.

Finally, we noted several differences in the variables that provided the most explanatory power in each category for different types of dental services, as well as probability vs. expenditure definitions.

III. EXPLAINING ADULTS' USE OF DENTAL SERVICES: THE EXPLANATORY FACTORS THAT UNDERLIE SOCIODEMOGRAPHIC GROUP DIFFERENCES

RATIONALE

Attempts to alter the propensity to use dental services require information not only about what factors explain use and nonuse, but about which are the more important explanatory factors. Interventions designed to increase the likelihood that adults will use needed dental services should be more successful if they are targeted toward characteristics that are mutable *and* that more strongly affect this propensity.

Previous studies suggest that users and nonusers can be distinguished by differences in such sociodemographic characteristics as ethnicity, age, education, and family income (Aday, Andersen, and Fleming, 1980; National Center for Health Statistics, 1982a). Our own analyses, as reported in Sec. II, confirmed these group differences in the Health Insurance Experiment database. Such findings indicate to which subgroups of the population interventions designed to alter utilization behavior should be targeted. With few exceptions (e.g., cash or in-kind subsidies to income), such characteristics cannot be changed. There are good reasons, however, to expect that sociodemographic differences in utilization behavior actually reflect underlying differences in characteristics that might be altered. The databases available to earlier studies, however, rarely allowed investigators to address the question of which underlying and possibly mutable characteristics the sociodemographic group variations reflect.

The comprehensive set of variables in the HIE database, and the availability of structural equation techniques that partition direct and indirect explanatory effects, enabled us to study this question. The analyses discussed in this chapter examined the relative importance of each explanatory category, in the presence of other categories, to explaining the probability of dental utilization by adults. They address the second question posed in the Introduction: To what extent do sociodemographic variations in probability of use reflect underlying differences in such factors as need, satisfaction with dental care, other health-related beliefs and attitudes, or continuity of care?

To our knowledge, these analyses represent the first application of structural equation techniques to research on dental utilization. We

therefore viewed the development of the structural equation models as generating theory rather than testing it, and as producing preliminary rather than conclusive results. Accordingly, we adopted fairly generous criteria against which to test the fit of the models.

METHODS

Sample and Data

To examine the relative importance of the explanatory factors, we studied the random subset of adult HIE enrollees ages 14 and older who were eligible for insurance benefits throughout the second experimental year and had received the oral health examination at the study's outset (n = approximately 800 in each of the exploratory and confirmatory samples). The characteristics of the full samples were described in Sec. II; see also App. Table A.1.

The dependent variable was the dichotomous indicator of any dental use during the year. We studied only the probability of dental use among adults because the explanatory variables generally did a better job of predicting probability than expenditures (see Sec. II). With minor exceptions, the explanatory variables we considered were those that we retained to define the following categories in the probability equations (see Table 3): oral health status; general health perceptions; satisfaction with dental care; health-related beliefs, knowledge, and attitudes; and continuity of care. In the satisfaction category, we replaced the residualized General Satisfaction measure and the square of Access with the untransformed variables, and dropped the interaction of the Availability and Pain Management measures. (These changes were required for the measurement portion of the structural equation model; see below.)

To conserve degrees of freedom, we replaced the four dummy coinsurance terms with a scalar, on which higher scores indicated less generous insurance.[1] Because we were interested in distinguishing the relative importance of the sociodemographic characteristics while holding the experimental treatment constant, generosity of coinsurance was treated as a separate explanatory category. In addition, the four dummy study site terms were also replaced by a scalar; the sites were

[1]The scalar was constructed by taking the square root of the sum of squared coinsurance terms. This form tends to fit the pattern observed among insurance plans by Manning et al. (1985) better than a linear scalar.

ordered in terms of the average length of wait for new patients to get a dental appointment, an indicator of stress on the delivery system.[2]

Analytic Methods

Relative Importance of Explanatory Categories. We relied on maximum likelihood logistic regression techniques to estimate the direct effects of each explanatory category on the probability of any annual dental utilization by adults.

To test the importance of each category in the presence of other explanatory categories, we did a series of stepwise regressions in the exploratory subsample. We began with a regression that included all explanatory categories; each subsequent equation excluded the variables from one explanatory category. The χ^2-difference between each of these latter models and the initial model provided an estimate of the explanatory power lost by excluding that category. We cross-validated our results in the confirmatory subsample.

For comparison, we estimated the importance of each category considered alone by regressing the dichotomous use vs. nonuse indicator on all variables in each category, one category at a time. We also did a split-sample analysis with cross-validation at this step.

Direct and Indirect Effects of Explanatory Categories. Using structural equation techniques (Bentler, 1986; Jöreskog and Sörbom, 1979), we developed models that simultaneously tested the direct and indirect effects of the explanatory categories on probability of use. We first developed a measurement model that related observed (i.e., measured) variables to latent variables in the exploratory subsample.

Our proposed measurement model appears in Fig. 1. (Boxes denote measured variables and circles denote hypothesized latent constructs. Arrows joining circles to boxes indicate the variable(s) that contribute to the interpretation of the latent constructs.) Because of our interest in the sociodemographic characteristics, we considered each separately. Each of these characteristics, as well as continuity of dental care and use vs. nonuse, was defined by a single measured variable and was assumed to be perfectly reliably measured.[3]

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[2]The site scalar was defined as follows: 1 = South Carolina; 2 = Seattle; 3 = Massachusetts. The data on average appointment waiting time came from a telephone survey of dentists' offices in each site done during the experiment's first year. Individual means for each of the two South Carolina sites (Charleston; Georgetown County) and the two Massachusetts sites (Fitchburg; Franklin County) were not available.

[3]This assumption is required when only one measured variable is available to define a construct in the measurement model portion of a structural equation model. The assumption fixes the parameter estimate for the measured variable as an indicator of the underlying construct at 1.00; thus, no error variance is estimated by the model.

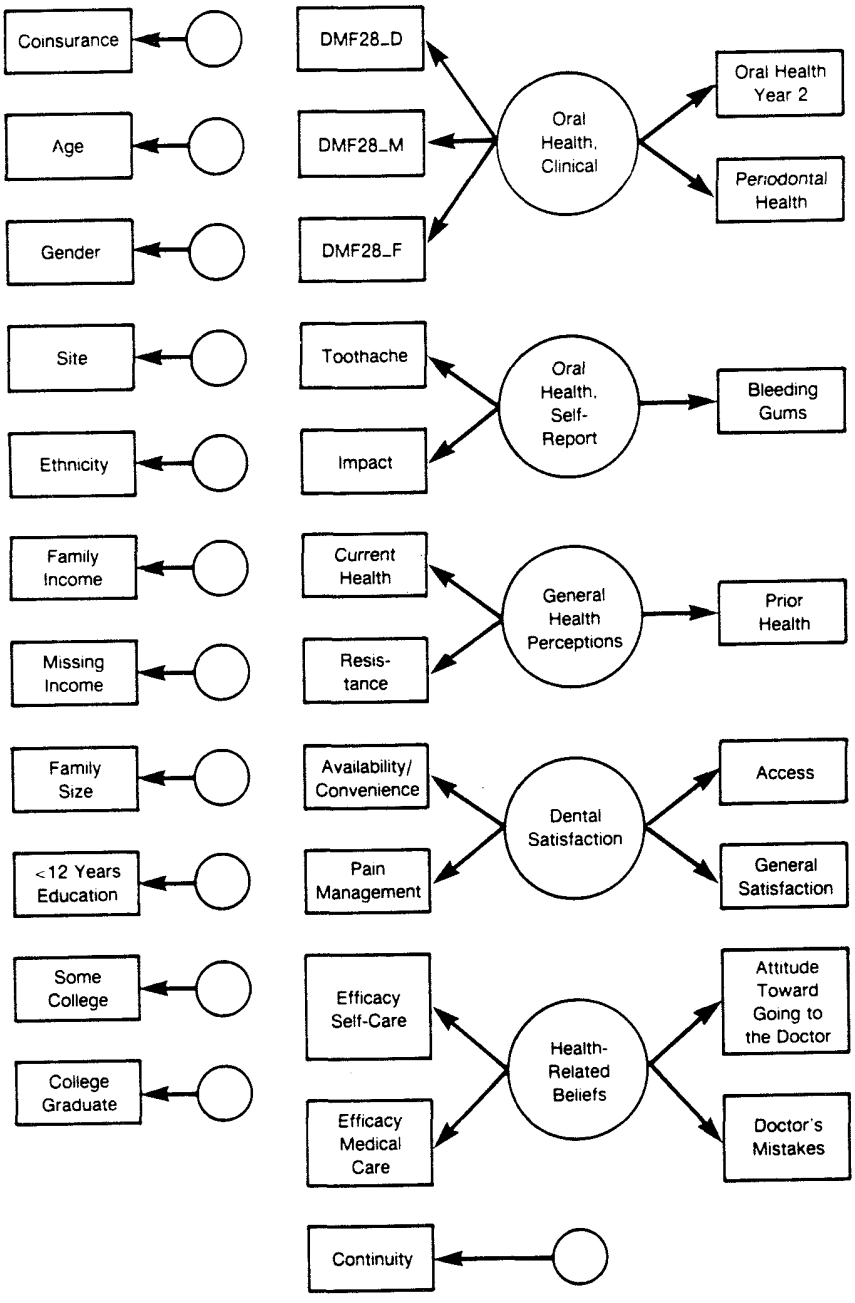


Fig. 1—Proposed measurement model, probability of adults' use of dental services

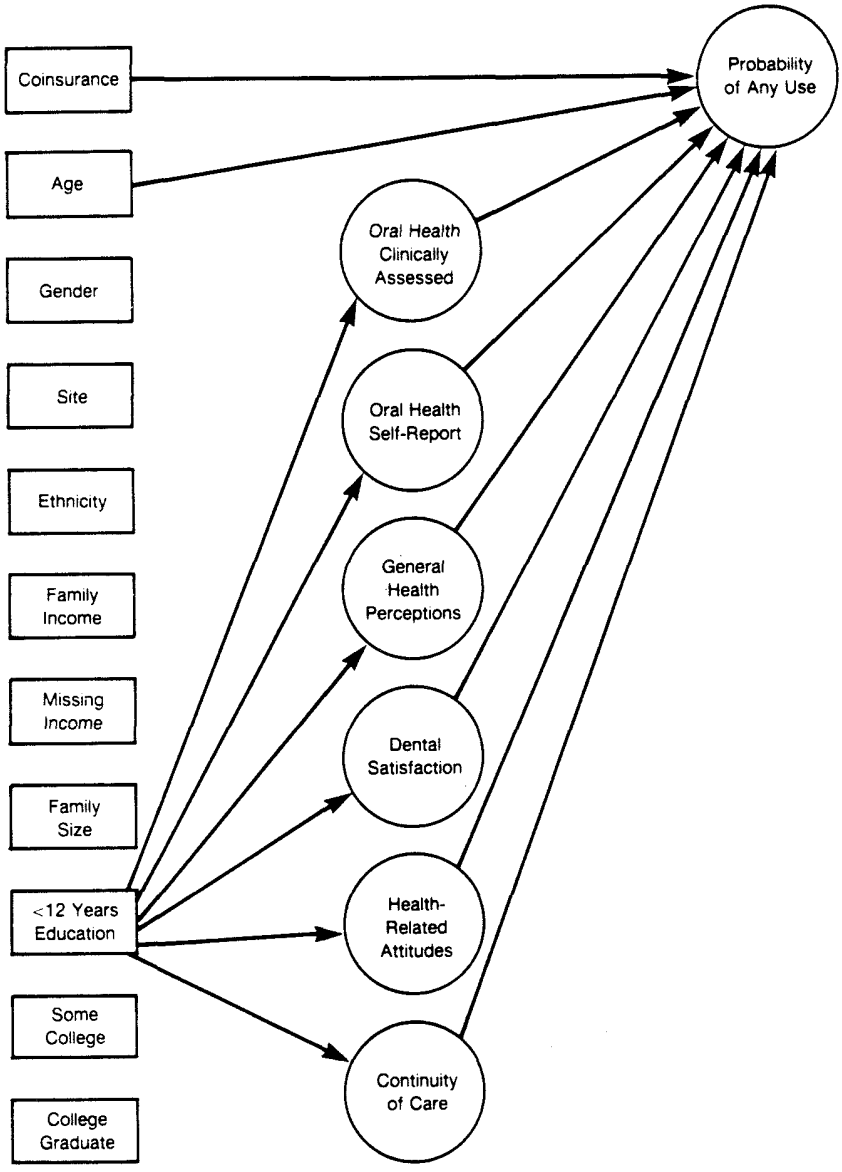
Five latent variables or common factors (clinically assessed oral health; self-report oral health; dental satisfaction; general health perceptions; and health-related knowledge, beliefs, and other attitudes) were defined by the measured variables in these explanatory categories. We posited that the measured variables in a given category (e.g., attitudes toward access of dental care and toward pain management) defined only the relevant explanatory factor (in this example, satisfaction with dental care); they did not contribute to the definition of other latent variables.

To evaluate the measurement model, we used the cutoff value associated with a one-tailed test at the .01 α level ($z = |2.33|$); the same standard was employed when we cross-validated the measurement model on the confirmatory subsample. We chose this fairly stringent criterion because the hypothesized measurement model was based on considerable empirical work with the variables in each of the explanatory categories (as reported in Sec. II).

Once the measurement model was defined, we posited the causal structure that defined relationships among explanatory factors (observed and latent) and the probability of use. Our initial causal structure hypothesized a two-stage explanatory model (see Fig. 2). Specifically, we expected that each of the sociodemographic variables and each of the six intervening variables (the five latent factors identified above and the continuity measure) would directly affect the probability of use. We also expected that each of the sociodemographic characteristics would directly affect each of six intervening variables, thereby indirectly affecting utilization.

The sociodemographic variables were allowed to intercorrelate. To reduce the number of parameters that would be estimated and thus to conserve degrees of freedom for parameters of interest, these correlations were fixed at their sample estimates. Similarly, although the intervening variables were allowed to intercorrelate, their unique variances (the variance in each latent variable that was not explained by its measured variables) were not allowed to correlate.

Our preliminary analyses in the exploratory subsample evaluated the significance of the hypothesized effects in the causal structure. In these preliminary analyses, we evaluated parameter significance using the cutoff value associated with an α of < 0.16 ($t = |1.4|$). (Because we had no empirical work on which to base hypotheses, we used a fairly generous significance level in examining the causal structure.) All effects that yielded insignificant parameter estimates were dropped; their deletion was corroborated by appropriately specified χ^2-difference tests. The final specification of the causal structure was reestimated in the exploratory subsample; it included only those parameters that met



NOTE: This is intended to be representational; not all proposed paths are indicated, because of the number of lines that would have been drawn. As indicated in the text, we proposed direct effects for all sociodemographic variables on all intervening variables and on probability of use.

Fig. 2—Proposed causal structure, probability of adults' use of dental services

both criteria. We then cross-validated the final measurement and causal structures on the confirmatory subsample.

The final (or saturated) model yielded the least restricted causal structure and thus provided a minimum χ^2 against which losses in information from deleting direct or indirect effects could be evaluated. (The hypothesis that an effect is not present, or that the parameter is zero, adds a restriction to the model.)

Once we had specified the final causal structure, we estimated a series of nested models. When one parameter was deleted from the saturated model, each nested model tested the hypothesis that a particular explanatory category had no direct effect on the probability of utilization. Calculation of the difference in χ^2 between each of these models and the saturated model provided statistical evidence of the importance of the direct effect of the deleted category on use. A χ^2-difference corresponding to an α of <0.05 was taken as sufficient reason to reject the null hypothesis. Failure to reject the null hypothesis meant that the specified explanatory category affected utilization only indirectly through the other explanatory variables (in the case of the sociodemographics) or not at all (in the case of the intervening explanatory variables).

Given the size of our samples, we were virtually assured that the conventional goodness-of-fit statistic (likelihood ratio χ^2) would indicate poor overall fit. We therefore used two statistics, Bentler and Bonett's (1980) normed (δ) and nonnormed (ρ) indices, to better assess overall model fit. These two indices compare the model of interest with the null model of complete independence for their samples.[4] Because we considered this work more at the theory-generation than theory-testing stage, we were willing to accept models that did not meet traditional fit criteria (that had fit indices of less than 0.90).

RESULTS

Relative Importance of Explanatory Categories in Predicting Probability of Use: Direct Effects Only

Table 5 presents results from analyses designed to indicate the importance of each of the explanatory categories relative to the others in predicting probability of use. Entries in the Build-Down column report the difference in χ^2 for two equations. One included the best subset of explanatory variables for the category defined by the row

[4]As the most restricted case (all parameters are hypothesized to be zero), the null model provides a maximum χ^2 against which gains in information from hypothesizing nonzero relationships could be evaluated.

Table 5

RELATIVE IMPORTANCE OF EXPLANATORY CATEGORIES IN EXPLAINING PROBABILITY OF ADULTS' UTILIZATION

Explanatory Category	df	Build-Down[a]		Category Only[b]	
		E	C	E	C
Oral Health Status					
Clinically assessed	5	28.36[c]	18.30[c]	91.12[c]	58.74[c]
Self-report	3	0.54	3.00	11.74[c]	21.48[c]
General Health Perceptions	3	1.96	2.17	4.50	3.14
Satisfaction with Dental Care	4	2.23	1.30	22.35[c]	10.40[d]
Health-Related Beliefs	4	4.16	13.79[c]	16.12[c]	37.77[c]
Continuity	1	3.19	7.99[d]	27.26[c]	22.08[c]
Sociodemographics					
Coinsurance	1	6.81[c]	26.07[c]	11.81[c]	35.16[c]
Other characteristics	10	26.36[c]	27.65[c]	83.79[c]	73.47[c]
Full model	31	142.34[c]	160.28[c]	—	—

NOTE: df = degrees of freedom, E = explanatory sample, c = confirmatory sample.

[a]Column entries indicate χ^2 difference tests between the model that included measures in all categories and the model that excluded the category named by the row.

[b]Column entries indicate χ^2 for the model that included only the category named by the row.

[c]$p < 0.01$.

[d]$p < 0.05$.

label and the other included all variables *except* those in that category. A significant χ^2-difference indicates that category contributed significant incremental variance to explaining the probability of using dental services. For example, we observed a χ^2-difference of 28.36 ($p < 0.01$) when the clinically assessed oral health measures were dropped from the model in the exploratory subsample, and of 18.30 ($p < 0.01$) in the confirmatory subsample. For comparison, the Category Only column indicates the χ^2 for the category considered alone in the explanatory and confirmatory samples.[5]

[5]Results in these columns differ from those reported in Table 3 because the sample in these analyses had complete data on *all* explanatory variables; the sample in Table 3 had complete data on a given set of explanatory variables.

Three explanatory categories—clincally assessed oral health status, sociodemographic characteristics, and generosity of dental health insurance—made significant incremental contributions to explaining the probability of dental use in both exploratory and confirmatory samples. In the presence of other explanatory factors, neither self-report oral health status nor satisfaction with dental care was significant, a finding that replicated across samples. Results for the two other explanatory categories considered here—continuity of provider and health-related knowledge, beliefs, and attitudes—were less clear-cut. Each provided significant unique explanatory variance, but only in the confirmatory subsample.

Relative Importance of Explanatory Categories in Predicting Probability Of Use: Direct and Indirect Effects

Measurement Structure. Figure 3 presents the final measurement structure from the structural equation model as replicated in the confirmatory subsample. As before, boxes denote measured variables and circles denote hypothesized latent constructs. Arrows joining circles to boxes indicate the variable(s) that contribute to the interpretation of the latent constructs. The numbers indicate standardized parameter estimates, or factor loadings. Estimates for all factor loadings were significant ($p < 0.01$, one-tailed test) and in the hypothesized direction.

The sociodemographic characteristics and continuity of dental care were each defined by one measured variable. (As noted earlier, we had fixed these parameter estimates at 1.0; standardized estimates varied slightly as a result of rounding error.) Each of the other intervening factors was defined by multiple measured variables whose parameter estimates provide information about the interpretation of the latent factors.

Clinically assessed oral health was largely a measure of poor oral health and use in the past (DMF28_F is a count of filled teeth); current good health as revealed by absence of tooth decay and periodontal disease also played a major role in its interpretation. Self-reported oral health chiefly reflected the impact of dental health (absence of pain and worry, and nonavoidance of conversation because of dental problems). Belief in the efficacy of self-care dominated the interpretation of the health-related knowledge, beliefs, and attitudes factor. Similarly, favorable ratings of current health played a major role on the general health perceptions factor. Favorable attitudes toward the accessibility of dental care were key to interpreting the

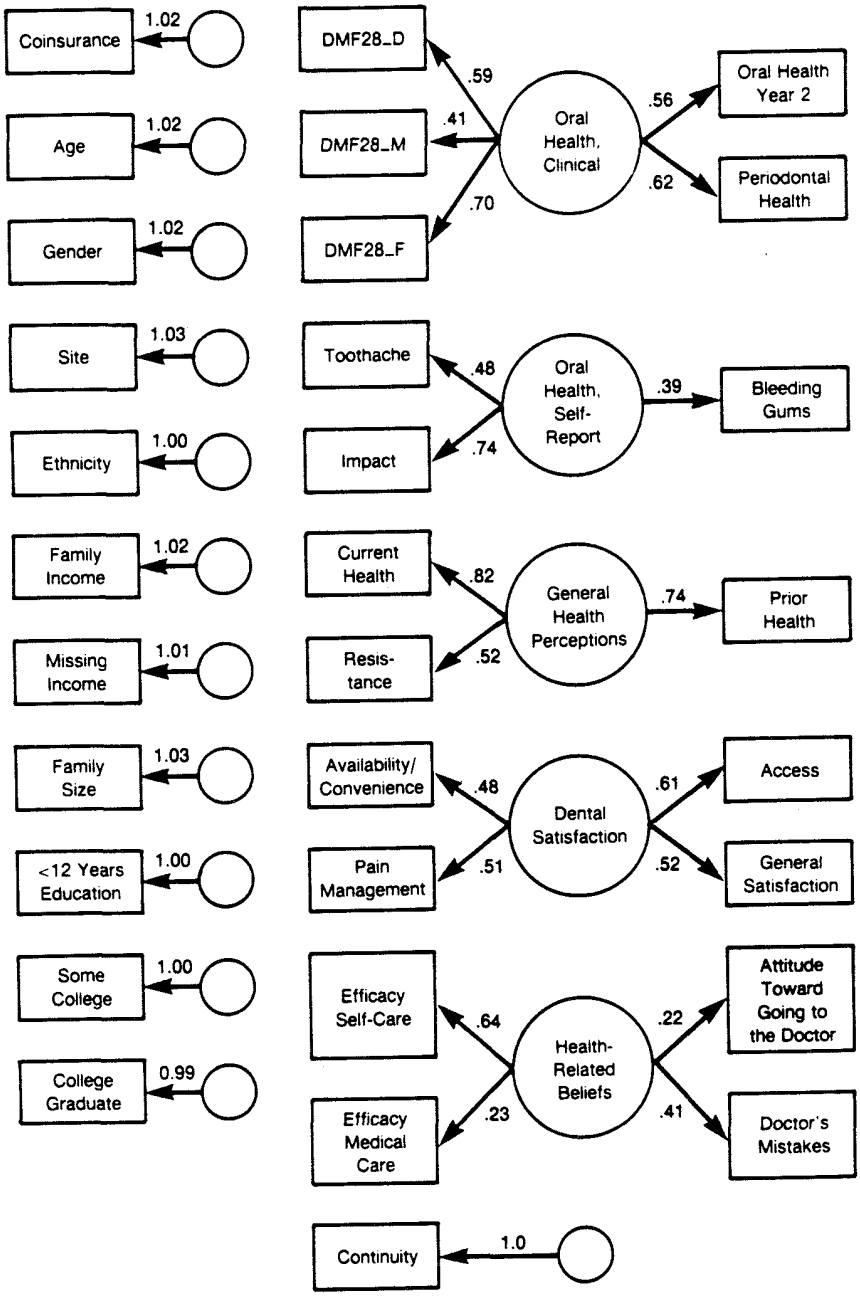


Fig. 3—Final measurement model, probability of adult's use of dental services (confirmatory sample)

dental satisfaction factor, followed closely by attitudes toward care in general, pain management, and availability and convenience of services.

Causal Structure. Table 6 presents the standardized regression coefficient for each causal path in the final model in the confirmatory

Table 6

PARAMETER ESTIMATES FOR CAUSAL STRUCTURE, PROBABILITY OF ADULTS' DENTAL USE
(Confirmatory sample)

Explanatory Variables	Dependent Variables						
	Use	Clinical Oral	Self-Report Oral	General Health	Satis-faction	Beliefs	Continuity
Intervening							
Oral health status							
Clinically assessed	.23[a]						
Self-report	−.07						
General health perceptions	−.03						
Satisfaction with dental care	−.03						
Health-related beliefs	.15[a]						
Continuity	.10[b]						
Sociodemographics[a]							
Age	.07[b]	−.15[a]	—[c]	−.21[a]	.06	.03	—
Gender (female)	.04	.16[a]	—	—	—	—	.04
Ethnicity (black)	.01	−.25[a]	−.14[a]	−.08[b]	−.11	−.21[a]	−.08[b]
Family income	.14[a]	.14[a]	.17[a]	—	−.01	.18[a]	.12[a]
Missing income	.01	−.05	.04	—	—	—	—
Family size	.01	−.06	−.03	—	—	—	—
< 12 years education	.05	−.17	−.06	—	—	—	—
Some college	.04	.09	.04	—	—	—	—
College graduate	.07[b]	.22[a]	.08[b]	—	—	—	−.02
Site	.04	.19[a]	.08	.05	.09[b]	.15[a]	.04
Coinsurance	−.20[a]	—	—	—	−.01	—	—
R^2	.20	.37	.08	.08	.03	.13	.04

[a] $p < .01$.
[b] $p < 0.05$.
[c] — indicates parameter was not estimated in final causal structure in exploratory or confirmatory samples because it yielded an insignificant estimate in preliminary model testing in the exploratory sample.

subsample. Coefficients indicating the estimated direct effect of each explanatory variable appear in the first column. Coefficients in the remaining columns indicate the direct effects of the sociodemographics on the intervening variables; all effects estimated here had yielded significant estimates in the exploratory subsample. The bottom row indicates the amount of variance explained for each of the intervening variables.

The model accounted fairly well for the probability of use (R^2 = 0.20) and clinically assessed oral health (R^2 = 0.34). It performed modestly well in accounting for general attitudes (R^2 = 0.13), and poorly for general health perceptions, perceived oral health, continuity, and dental satisfaction (see bottom row, Table 6).

The final causal structure as estimated in the confirmatory subsample is summarized in Fig. 4. For simplicity, only those parameters that had significant direct or indirect effects on the probability of use are included. As expected, given the number of parameters estimated and the large sample, the final model demonstrated poor goodness-of-fit compared with the null model (see bottom row, Table 7).[6]

The significant contributions of ethnicity, gender, and site to the explanation of probability of use were all indirect. Ethnicity had a significant effect on all intervening variables. The effects of site on use were indirect through clinically assessed oral health, dental satisfaction, and health-related knowledge; and those of gender were indirect through its effect on clinically assessed oral health. Age, income, and college education exerted significant direct effects on probability of use, as did generosity of dental health insurance. Age, income, and college education also had significant indirect effects through the intervening variables (most commonly, clinically assessed oral health status).

Clinically assessed oral health, continuity of dental provider, and health-related beliefs, knowledge, and attitudes each had significant direct effects on the probability of use. Older persons, men, blacks, those with less education, and those with lower incomes all had poorer oral health on clinical assessment; those with poorer oral health in turn were more likely to use dental care. Blacks and those with lower incomes were more likely to believe in the efficacy of self-care and less likely to have a regular dentist, both of which contributed to their smaller likelihood of getting dental care.

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[6]We tested alternative models at the exploratory stage (e.g., models that allowed error variances to correlate, and that included secondary loadings in the measurement structure), which improved the model's overall fit to conventional standards (i.e., δ or ρ = 0.90). These model improvements were obtained without substantially affecting the causal structure reported above, although they complicated the interpretation of the measurement structure considerably. Thus, we report and discuss as our final model the one that did *not* estimate correlated error variances or secondary loadings.

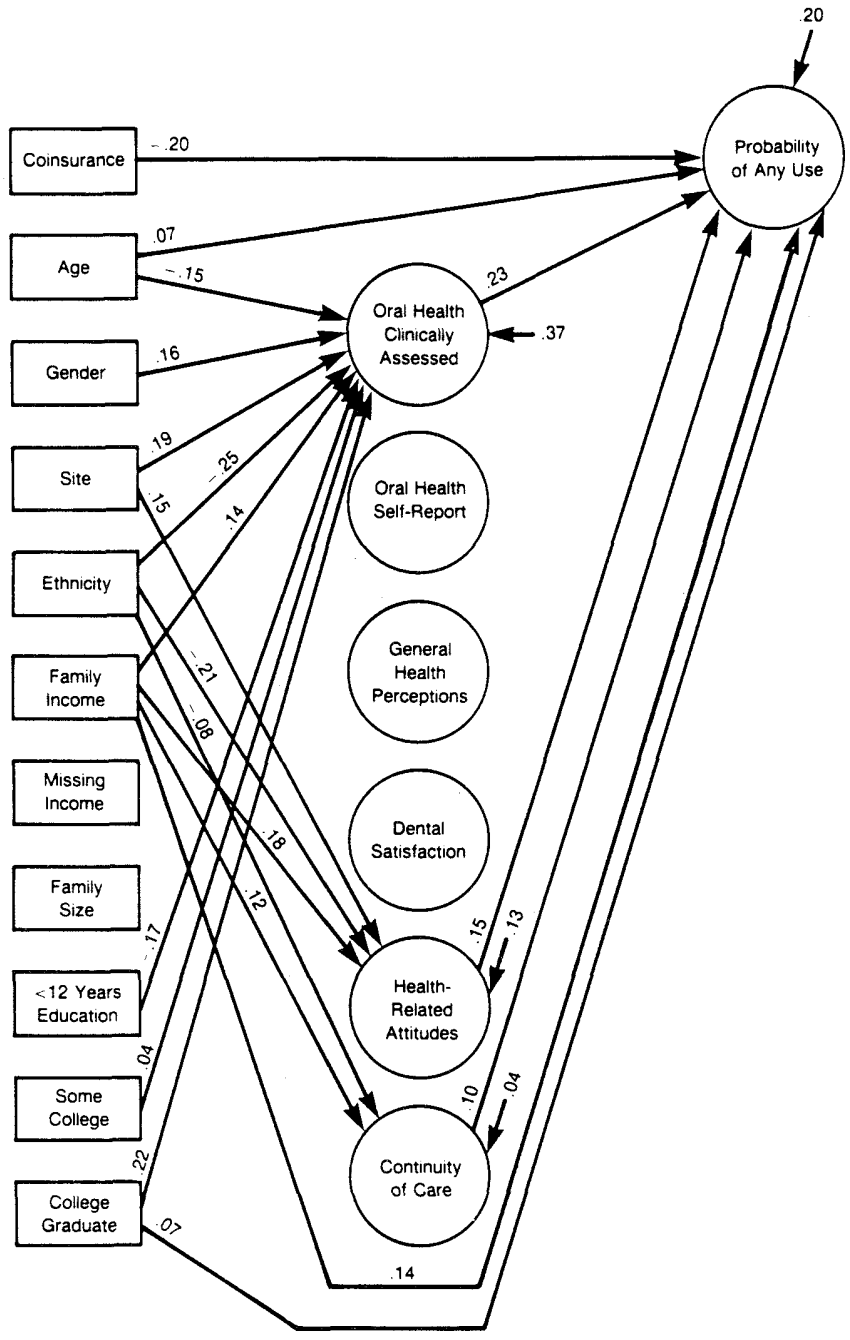

Fig. 4—Final causal structure, probability of adults' use of dental services

Table 7

RELATIVE IMPORTANCE OF EXPLANATORY FACTORS IN STRUCTURAL MODEL: RESULTS OF χ^2 DIFFERENCE TESTS

Explanatory Category	df	Exploratory	Confirmatory
Oral Health Status			
Clinically assessed	1	19.62[a]	13.04[a]
Self-report	1	1.73	1.53
General Health Perceptions	1	0.16	0.35
Satisfaction with Dental Care	1	1.00	0.27
Health-Related Beliefs	1	0.08	5.77[b]
Continuity of Care	1	0.18	4.76[b]
Sociodemographics			
Coinsurance	1	6.84[a]	30.50[a]
All others	10	15.62	21.00[b]
Full Model			
χ^2	412	1226.30	1417.46
δ		0.75	0.67
ρ		0.78	0.68

[a] $p < 0.01$.
[b] $p < 0.05$.

Younger persons, those with lower incomes, and those with less generous dental insurance were less likely to see the dentist *regardless* of underlying differences in oral health, general health perceptions, attitudes toward dental care, health-related beliefs, and whether they had a regular dentist. Of these, the effects of coinsurance and income were relatively stronger ($p < 0.01$); those of age and education were weaker although significant ($p < 0.05$).

Direct vs. Indirect Effects of Explanatory Categories

Table 7 presents the χ^2-differences that resulted from comparing the final model (as specified in Table 6) with those models that deleted, one at a time, the direct effect of each of the major explanatory factors on the probability of dental use. These comparisons were made in the exploratory sample and replicated in the confirmatory sample.

These formal tests support the findings drawn from observation of the model's relationship as outlined above. As expected, because the

HIE's experimental design eliminated the relationship between insurance status and sample characteristics, generosity of insurance exerted a strong direct effect on probability of use. When underlying group differences in the intervening variables were considered, the direct effect of the other sociodemographic variables as a set was substantially reduced (the p-value was insignificant in the exploratory sample and barely significant in the confirmatory sample). Oral health (as clinically assessed) showed strong effects on use. Continuity and health-related beliefs, knowledge, and attitudes were also significant in the confirmatory subsample. To answer the question posed at the outset of our analysis, these three categories and their key explanatory variables (filled teeth, in the case of oral health status; continuity; and beliefs in the efficacy of self-care, in the case of health-related beliefs, knowledge, and attitudes) are prime candidates for the subset of underlying group differences that account for much of the effect of sociodemographic characteristics (other than generosity of dental insurance) on probability of use by adults.

IV. EXPLAINING DENTAL UTILIZATION BEHAVIOR OF CHILDREN

RATIONALE

Our interest in developing models of children's utilization of dental services separately from those we developed for adults stemmed from both theoretical and practical considerations. Few previous studies of children's dental utilization included explanatory variables other than sociodemographic characteristics (Kriesberg and Treiman, 1960; Lawson, 1980; Newman, 1971; Newman and Anderson, 1972; Newman and Larsen, 1980), and many necessarily considered family-level characteristics (e.g., family income, ethnicity). Thus, we had a theoretical interest in exploring what factors, in addition to sociodemographic characteristics, might contribute to our understanding of whether children use dental care and how much is spent on dental care once children obtain services.

In these analyses, our distinction of children and adults as those under 14 years of age vs. those 14 years and older results from the (somewhat arbitrary) distinction adopted for the Health Insurance Experiment in self- vs. proxy-administration of health questionnaires, which provided data for most of our explanatory measures. Questionnaires pertaining to children younger than 14 were proxy-administered by a parent, usually the mother. In addition, the set of explanatory measures available for those younger than 14 years in the HIE database was far less comprehensive than that for adults. In particular, measures of most attitudinal variables were obtained only on self-administered questionnaires and thus scored only for those ages 14 years and older. To remedy this situation, we broadened the definition of explanatory variables in our analyses of children's utilization to include measures of parent's satisfaction with own dental care and parent's health-related attitudes, beliefs, and knowledge.

The analyses reported here were designed to:

- Identify which among several measures of most explanatory categories provide the most explanatory power to models of children's utilization, and
- Examine whether conclusions regarding the definition of the explanatory factors depend on the definition of utilization considered (probability of any use vs. expenditures by users).

Results from these analyses provide at least preliminary answers to the first and third questions we posed in the Introduction: What explains the substantial percentage of individuals with dental health insurance who do not use dental care during the year? and Do the same or different factors account for care-seeking and for amount of care once an individual enters the system? Given the smaller sample of children than adults and the related poorer precision, we devoted fewer project resources to analyses of children's utilization. Thus, these analyses consider the explanatory categories separately; we did not examine the relative contribution of categories to explanatory models, nor did we study the factors that underlie sociodemographic group differences in utilization among children. We also consider our results preliminary because the sample size did not permit cross-validation; thus, we may well have over-fit our models of the explanatory factors. Nevertheless, given the relative paucity of multivariate studies to explain children's dental utilization, these analyses do make a contribution to our understanding of this behavior.

With these exceptions, the sampling decisions and methods used to develop explanatory models of children's utilization parallel those used in our work with models of adults' utilization. Those who have read Sec. II will find the following Methods section redundant with information there. Recognizing that some readers will be interested principally in children's utilization, we reiterate the methodological details here so this portion of our work will be self-contained.

METHODS

Analytic Sample

The analytic sample included children who were eligible for insurance benefits during the entire second year of the Health Insurance Experiment. To ensure greater generalization of our results, we were interested in explaining "steady-state" utilization rather than the transitory response to dental insurance coverage observed during the first year (Manning et al., 1985, 1986). Studying utilization during the second year avoided this transitory surge in demand.

Children whose families had dropped out of the study or been terminated administratively and those who were eligible for partial-year coverage were excluded from our analyses.[1] In addition, children

[1]Dropouts accounted for most of the sample loss, and virtually all such attrition occurred during the study's first year. Given the large transitory surge in demand for dental services observed during the first year of experimental insurance coverage

younger than four years of age were excluded for two reasons. First, oral health status measures were not available for those younger than three. Second, the three-year-olds were excluded primarily because the definition of clinically assessed oral health for this age group (based on the def index)[2] differed markedly from that for those with mixed or permanent dentition (based on the DMF28). Although separate age-specific analyses would have resolved this problem, the sample of three-year-olds was small (n = 133) and accounted for very little utilization. Thus, we lost little precision by excluding this group.

The experiment ran from 1976 through 1982 in the sites included in the analysis (Seattle, Washington; Fitchburg, and Franklin County, Massachusetts; Charleston, and Georgetown County, South Carolina). Our analyses excluded enrollees from the Dayton site, where dental benefits were phased in on a different schedule (Manning et al., 1985, 1986). Except for certain intentional exclusions, the sample was representative of the general populations in the sites studied. The experiment excluded families with family heads older than 62 years; families with annual incomes over $57,000 (in 1983 dollars), some 3 percent of families contacted; those eligible for the Medicare disability program; the institutionalized; the military and their dependents; and veterans with service-connected disabilities.

We studied a sample of 1311 children ages 4 through 13 years at enrollment. Table 8 presents information on selected sociodemographic and other characteristics of this sample, across and within site. The sample averaged 9.0 years of age and was divided fairly evenly between girls and boys. On average, the health care decisionmaker in households with children had completed 11.9 years of education. The average annual family income was $13,954. Almost 17 percent of families with children were black. Among the health-care decisionmakers, 41.5 percent were employed and 79 percent were married. The average family numbered five members. Some 11 percent of families with children were on AFDC at the study's outset. As in the full sample, almost 70 percent of families were assigned a three-year term of participation; a random 64 percent of children ages 4 through 13 years received a clinical examination at enrollment.

(Manning et al., 1985, 1986), we did not have enough precision to detect any differences in dental utilization between dropouts and those remaining in the analytic sample (Manning, personal communication). We do know that this attrition did not bias analyses of medical care expenditures (Manning et al., in press).

[2]The def index is a count of *d*ecayed, indicated for *e*xtraction, and *f*illed primary teeth, and was scored for all children younger than eleven years. The DMF28 was scored for all those six years old and older.

Table 8

SELECTED CHARACTERISTICS ACROSS SITES AND BY SITE, CHILDREN'S SAMPLE
(Standard errors in parentheses)

Characteristic	Sites Combined	Seattle	Massa-chusetts	South Carolina
Sample Size				
Individuals	1311	476	396	439
Families	676	281	184	211
Sociodemographic Characteristics				
Age (years)	9.0	8.9	9.0	9.0
	(.08)	(.13)	(.14)	(.14)
Male (%)	52.0	51.7	52.8	51.8
	(.01)	(.02)	(.03)	(.02)
Education (years)[a]	11.9	12.4	12.3	10.9
	(.10)	(.11)	(.18)	(.20)
Income ($)[a]	13,954	15,599	12,918	12,668
	(258)	(403)	(417)	(488)
Black (%)[a]	16.9	2.1	1.6	49.9
	(.01)	(.01)	(.01)	(.03)
Employed (%)[a,b]	41.5	35.7	42.9	47.8
	(.02)	(.03)	(.04)	(.03)
Married (%)[a,b]	79.0	80.6	80.3	75.7
	(.02)	(.02)	(.03)	(.03)
Family size[a]	4.7	4.5	4.6	4.9
	(.06)	(.08)	(.10)	(.14)
Prior Insurance Coverage				
AFDC (%)[a]	9.6	8.6	13.3	7.9
	(.01)	(.02)	(.02)	(.02)
Experimental Design Variables				
3-year sample (%)	67.3	59.1	72.8	73.5
	(.02)	(.03)	(.03)	(.03)
Enrollment physical (%)	64	58	79	59

[a]Statistics for these variables were calculated at the family level; those for all other variables represent person-level statistics.

[b]Data on these characteristics apply to the child's medical care decisionmaker, usually the female head of household.

Of the 1311 children, close to 1000 had fairly complete data on explanatory variables other than clinically assessed oral health; as indicated below, the clinical assessments were missing by design. Including the clinically assessed oral health measures, close to 800 children ages 4 through 13 years had complete data on *all* explanatory variables. Because these numbers were small relative to the adult sample, we did not split the children's sample for cross-validation analyses.

Data Collection

Among the explanatory variables, data on most sociodemographic characteristics were obtained at or before enrollment. Data on family income pertained to the experiment's first year. A random 64 percent of children received an enrollment dental examination, which provided the clinical assessments of oral health status. Data for all other explanatory variables came from parent-administered questionnaires fielded at the outset of the second experimental year in each site. Utilization variables were calculated from claims submitted throughout each participant's second experimental year.

Dependent Variables

For these analyses, we examined two dependent variables, a measure of the propensity to use dental services and a measure of the intensity of use:

- Probability of using any dental services; and
- Expenditures on dental services, per user.

The analytic sample was too small to disaggregate either utilization definition into its components (preventive, illness-related), as we had done in analyses of adults' utilization (see Sec. II).

The probability definition was a dichotomous variable (0,1), with "1" indicating the child made at least one visit during the year. The expenditure definition was expressed as the log of total dollars spent on dental services and was computed only for those children who made at least one visit during the year. Unlike counts of visits, expenditures reflect the amount, intensity, and quality of dental services. The log transformation minimized the skewness in the distribution of dental expenditures, thereby reducing the influence of large users on our conclusions.

Descriptive statistics for the utilization measures appear in App. Table A.17. Among the children, 66 percent used one or more dental services during the year.

Explanatory Variables

Based on theory and content analyses, we grouped the explanatory variables into eight categories:

- Oral health status,
- Parent's perceptions of the child's general health,
- Parent's satisfaction with dental care,
- Parent's health-related knowledge,
- Parent's health-related beliefs and other attitudes,
- Parent's health-related worry and concern,
- Continuity of dental care, and
- Sociodemographics.

All but continuity of dental care and parent's health-related knowledge were represented by several variables. Those in the oral health, satisfaction, and continuity categories referred specifically to dental health or care. Variables in the other categories referred to health more generically (general health perceptions) or to knowledge, beliefs, and attitudes about medical care or health care in general. Parent-specific variables were scored from data provided by the individual designated as the family's medical care decisionmaker; for virtually all children, this was their mother.[3]

Table 9 identifies each of the variables in these categories, and notes the meaning of scores on each variable. For the health status, satisfaction, attitudinal, and continuous sociodemographic variables, Table 9 indicates the direction of scoring—whether a higher score indicates better (+) or worse (−) health status,[4] or favorable (+) or unfavorable (−) attitudes, or more of the construct named by the variable's label (e.g., family size). Dummy variables were scored so that "1" represented the variable label. Descriptive statistics for the explanatory variables appear in App. Table A.17.

[3]Further information on the scoring, reliability, and validity of the explanatory variables in the HIE database is available elsewhere. For oral health status, see Smith et al. (1978) and Spolsky et al. (1983); parent's perceptions of child's general health (Eisen et al., 1979, 1980); health-related worry and concern (Davies and Ware, 1981; Ware, 1976; Ware, Davies-Avery, and Donald, 1978;); satisfaction with dental care and continuity of dental care (Davies and Ware, 1982); health-related knowledge (Newhouse, Donald, and Ware, 1981); and health-related beliefs and attitudes (Lau and Ware, 1981).

[4]In the case of DMF28_F, the count of filled teeth, whether a higher count indicates better or worse oral health status (or lesser or greater need) is somewhat ambiguous, because it depends on the scores for the other components of this index. Assuming few decayed or missing teeth, children with fewer filled teeth are in better oral health than those with more filled teeth. About children with few decayed or missing and several filled teeth, we know they were in poor oral health in the past, obtained services, and are probably in better current oral health status than those with many unfilled teeth.

Table 9

OPERATIONAL DEFINITIONS AND DIRECTION OF SCORING FOR EXPLANATORY VARIABLES, BY CATEGORY, CHILD UTILIZATION ANALYSES

Explanatory Category/Variable	Direction[a]	Definition
Oral Health Status		
Cinically Assessed		
DMF28_D	–	Count of decayed permanent teeth (based on 28)
DMF28_M	–	Count of missing permanent teeth (based on 28)
DMF28_F	?	Count of filled permanent teeth (based on 28)
Oral Hygiene Index	+	Continuous; higher scores indicate better oral hygiene
Common Self-Report Survey Measures		
Tooth or gum pain	–	Continuous; higher score indicates greater pain
Gums bleed	–	Dummy; 1 = reported bleeding gums in past 30 days
Wears braces		Dummy; 1 = wears braces
Parent's Perceptions of Child's General Health		
EGFP	+	Continuous; higher score indicates more favorable ratings of health
Current Health	+	Continuous; higher score indicates more favorable ratings of current health
Prior Health	+	Continuous; higher score indicates more favorable ratings of health in the past
Health Outlook	+	Continuous; higher score indicates more favorable ratings of health in the future
Resistance to Illness	+	Continuous; higher score indicates more favorable ratings of resistance to illness
Parent's Satisfaction with Dental Care		
Availability/Convenience	+	Continuous; higher score indicates more favorable attitudes toward the availability and convenience of dental services

Table 9—continued

Explanatory Category/Variable	Direction[a]	Definition
Access	+	Continuous; higher score indicates more favorable attitudes toward the accessibility of dental care
Cost of Care	+	Continuous; higher score indicates more favorable attitudes toward the costs of dental services
Technical Quality	+	Continuous; higher score indicates more favorable attitudes toward the technical and interpersonal aspects of dental care
Pain Management	+	Continuous; higher score indicates more favorable attitudes toward the dentist's management of dental pain
General Satisfaction	+	Continuous; higher score indicates greater satisfaction with dental care overall
Parent's Health-Related Knowledge		
Consumer Sophistication	+	Continuous; higher score indicates greater knowledge about medical care system
Parent's Health-Related Beliefs and Attitudes		
Efficacy of Self-Care	+	Continuous; higher score indicates greater belief in self-care
Efficacy of Doctor's Care	+	Continuous; higher score indicates greater belief in physician care
Attitude Toward Going to the Doctor	+	Continuous; higher score indicates more favorable attitudes toward going to the doctor
Doctor's Mistakes	–	Continuous; higher score indicates greater belief that doctors make mistakes
Belief in Role of Chance	–	Continuous; higher score indicates greater belief that chance plays role in health events
Parent's Health-Related Worry and Concern		
Health Worry	–	Continuous; higher score indicates greater worry about health
Health Concern	–	Continuous; higher score indicates greater concern about own health

Table 9—continued

Explanatory Category/Variable	Direction[a]	Definition
Sickness Orientation	–	Continuous; higher score indicates perception that sickness is a part of life
Continuity of Dental Care		
Continuity	+	Continuous; higher score indicates medical care decisionmaker had regular dentist and reported seeing same dentist on most visits
Sociodemographics		
Gender		Dummy; 1 = female
Age	+	Continuous; age at outset of second experimental year
Family size	+	Continuous; number of people covered by experimental insurance policy
Ethnicity		Dummy; 1 = black
Family income	+	Continuous; income during experiment's second year
Missing income		Dummy; 1 = family income missing and replaced with predicted value
Site (Fitchburg, Franklin County, Charleston, Georgetown County)		Dummies; 1 = specified site (Seattle is the hold-out site)
Plan (CO25, CO50, CO95, ID)		Dummies; 1 = assigned to specified coinsurance rate or individual deductible (ID) (Free is the hold-out plan)
Education (Less than high school; some college; college graduate)		Dummies; 1 = educational attainment as specified (high school graduate is the hold-out group)
AFDC recipient		Dummy; 1 = family receiving AFDC at enrollment
Missing AFDC		Dummy; 1 = AFDC data missing
Marital status		Dummy; 1 = medical care decisionmaker married
Employment status		Dummy; 1 = medical care decisionmaker employed
Number of household heads	+	Count of household heads
Birth order	+	Continuous; higher number = later born.

[a]Direction indicates whether higher score on variable represents better (+) or worse (–) health, in the case of the Oral Health Status and General Health Perceptions categories; favorable (+) or unfavorable (–) attitudes and beliefs, in the case of the Dental Satisfaction and Health-Related Beliefs, Knowledge, and Attitudes. In the case of DMF28_F, the direction of scoring is unclear because this variable reflects more than oral health status (see text).

Hypotheses

We began with several hypotheses regarding reasons for nonuse and low expenditures by users of dental services that we derived from reviews of the dental and medical literatures. All hypotheses pertain to explanation of annual, rather than lifetime, utilization, and to the relationship between a single explanatory category and utilization, all other factors held constant. In addition, many are based on theory or studies of adults' utilization, because the literature on children's utilization is considerably more sparse. In particular, we posited the following:

- *Children in poorer oral health are less likely to use services, while those in better oral health spend less when they use.* Findings from earlier studies prove inconsistent regarding the relationship of oral health status to probability of use. The directionality of this association may relate in part to whether the oral health assessment is self-report (better oral health associated with smaller likelihood of use, as reported by Newman and Anderson, 1972) or clinical examination (poorer oral health associated with lower rates of use, as reported by Freeman and Lambert, 1965, and Tyroler et al., 1965). To the extent that current oral health status reflects previous use, findings from earlier studies suggest that those currently in good oral health have used dental services and will continue to do so, and that those in poor oral health will be less likely to use them in the future (e.g., Newman and Anderson, 1972).
- *When parents hold favorable perceptions of children's health in general, the children are less likely to use services and spend less when they use.* To our knowledge, no previous research has studied the relationship between parental perceptions of the child's general health perceptions and either use of dental services or oral health status. To the extent that parental assessments of the child's general and oral health agree, we expect a negative relationship between general health perceptions and dental use (see above). To the degree that the same models explain both dental and medical care utilization, we would expect a negative relationship on the basis of research on general health perceptions and medical care utilization (e.g., Manning, Newhouse, and Ware, 1982).
- *Children whose parents are less satisfied with their own dental care providers are less likely to use dental services and probably spend less when they do so.* As we noted for adults, the expectation of a positive relationship between satisfaction and

probability of dental use carries both intuitive appeal and the support of empirical results, albeit results from "postdictive" studies (e.g., Bene, Novasky, and Geldart, 1974; Murray and Wiese, 1975; Stacey, Slome, and Musgrave, 1978). Although the relationship between satisfaction and expenditures has received little attention, we expect that if attitudes toward dental care services and providers influence willingness to comply with recommended utilization once in the system, all other things equal, parents who are less satisfied may be less likely to comply with recommendations regarding their children's dental care and thus will spend less.

- *Children whose parents have unfavorable health-related beliefs and attitudes, and who are less sophisticated about the medical care system, are less likely to use dental services and spend less when they do so.* Much of the data available on the relationship between dental health-related beliefs, attitudes, and knowledge and dental utilization come from studies of the Health Belief Model in adults (e.g., Haefner, 1974; Kegeles, 1963a,b), and results are inconclusive. When these factors do have significant effects on utilization, they tend to be negative, hence our hypothesis. Again, if similar factors explain medical and dental expenditures, we would also expect a negative relationship (Manning, Newhouse, and Ware, 1982).
- *Children whose parents have greater continuity of dental provider will be more likely to use services.* Definitions of continuity reflect, to a greater or lesser extent, past utilization; in at least one study (Newman and Anderson, 1972), continuity and previous use were synonymous. Given that those with more continuity are more likely to have used dental services in the past, they are also more likely to do so in the future. The theoretical relationship between continuity and expenditures is less clear, therefore we did not outline a directional hypothesis. To the extent that continuity of provider indicates a better relationship with the provider, theory regarding doctor-patient relationships and compliance (DiMatteo and DiNicola, 1982) suggests that parents with greater continuity would be more likely to follow prescribed treatment plans once they obtain care for their children, and thus may spend more on care for the child. Continuity of provider may, however, lead to better oral health status, which could mean fewer or less expensive services for users.

Analytic Methods

Our work on models of children's utilization progressed through several steps. Bivariate analyses were done to document the zero-order relationships among explanatory variables and between these variables and the different definitions of utilization. For independent variable categories with more than one measure in the HIE database, we did multivariate analyses to identify the subset of measures that "best" defined that category in an explanatory model of children's dental utilization. Throughout these analyses, we used fairly generous significance testing criteria. Because many of the relationships we were studying had received little previous attention, we wanted to err on the side of over-including variables to represent each explanatory category. We discuss below the specific analytic techniques used at each stage.

Bivariate Analyses. As appropriate, Pearson product-moment correlations or point-biserial correlations were computed using pairwise deletion; all the available sample was used to estimate each relationship. In some cases, we also examined cross-tabulations for pairs of categorical variables.

Our examination of relationships among variables within explanatory categories emphasized the oral health measures. Earlier studies of HIE data had provided information about relationships among variables within other categories (Davies and Ware, 1981, 1982; Eisen et al., 1979, 1980; Newhouse, Donald, and Ware, 1981). We also estimated correlations between all explanatory variables and both definitions of utilization.

Choosing Variables that "Best" Represent Each Explanatory Category. The HIE database provided several measures of all but continuity and health-related knowledge; see Table 9). To identify the subset of measures that "best" represented each of the remaining categories in an explanatory model of children's utilization, we used both "build-up" and "build-down" techniques.[5] As a general rule, we retained variables that passed both tests. These analyses were done separately for the two definitions of utilization (probability of any use, and total expenditures on dental care).

The initial rounds of these analyses relied on ordinary least-squares (OLS) regression techniques. Although OLS yielded biased parameter estimates for the probability equation, it provided approximately

[5]Build-down regression techniques are commonly used for this purpose. Multicollinearity, however, can lead to the incorrect inference that a variable is insignificant in build-down analyses. Because we preferred to err on the side of *including* variables, we also used build-up techniques, which are unaffected by multicollinearity but may result in inclusion of an insignificant variable if omitted variables are correlated with both the dependent variables and the explanatory variable in question. The "truth" lies somewhere between the answers provided by each technique.

correct inferences about relationships between explanatory variables and probability of use. The results reported here were based on final maximum likelihood logistic regressions (for the probability of use) and OLS (for expenditures by users) analyses, which yielded consistent parameter estimates and test statistics. Because of the substantial intrafamily correlations observed for utilization in the children's sample (ranging from 0.36 to 0.72, depending on the explanatory category considered), our final regressions corrected for intrafamily correlation.[6]

Build-Up Analyses. We first selected a core set of measures within each category on the basis of their performance in an initial OLS regression that included all measures in a given category to predict each dependent variable. We then obtained OLS estimates for the core variables in the prediction of each dependent variable.

Next, each of the remaining variables in the category was added to the core set individually, then two at a time, three at a time, etc.; the final model included all measures in that category. Incremental F-statistics were computed at each step to determine the explanatory value (in statistical terms) of adding different combinations of remaining variables to the core set.

There was one exception to this strategy. In the sociodemographics category, we included the experimental design variables (plan, site) in our models *a priori*, along with measures of all sociodemographic characteristics that had been used in earlier HIE analyses of the effects of cost-sharing on dental utilization (Manning et al., 1985). Only six variables (employment status of medical care decisionmaker, number of family heads, marital status of medical care decisionmaker, whether the family was on AFDC at enrollment, whether AFDC status was missing, and birth order of the child; see Table 9) were candidates for exclusion.

Build-Down Analyses. We first estimated a model that included all of the independent variables within a given category. We then ran a series of regressions, each excluding one variable from the category. Comparison of the F-tests for the first and subsequent regressions indicated the incremental explanatory power of the excluded variable. A separate series of regressions was done for each category and each dependent variable.

Based on results from these analyses, we selected the measures that best represented each independent variable category. Specifically, the measures we retained for each category generally yielded significant ($t \geq |1.414|$, $p \leq 0.15$) (Mallows, 1973) and stable parameter estimates in build-up analyses or significant incremental validity in the build-down analyses.

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[6]For this purpose, we used the SAS software MLLOGIT and MLREG provided by RAND statistician William H. Rogers.

RESULTS

The data in Table 10 summarize the detailed results reported in App. Tables A.16 and A.17.[7] Entries in Table 10 indicate the direction (+ positive or – negative) of significant ($p < 0.05$) bivariate relationships for all explanatory variables and each definition of utilization (see cols. headed "Bivariate"). Entries also indicate the direction of significant ($t \geq |1.414|$) relationships from multivariate analyses for those variables that were retained after the build-up and build-down analyses (see cols. headed "Multivariate"). Variables categories that we retained for the probability definition of use are marked *, and for the expenditures definition, †. An S indicates that the set of retained variables in the category was significantly ($p < 0.10$) related to the dependent utilization variable.

When considered alone, each set of explanatory variables except the parent's health-related beliefs and attitudes was significantly related to the probability that children would use dental services. Each set except the parent's health-related knowledge explained a significant amount of variance in expenditures. In all cases, the variable(s) we excluded from each of the explanatory sets made insignificant incremental contributions to variance explained by the retained subset (see App. Table A.17).

Given our substantive interest in the variables that explain nonuse, our comments for the probability equation emphasize relationships that are *opposite* those shown in Table 10 (because the dependent dichotomous variable was actually scored to indicate use). We note those few instances where relationships observed in bivariate analyses changed when we considered multiple measures to determine the "best" specification of each category and comment on differences in the best definition of each category for the probability of using dental care compared with expenditures on dental services by users.

Oral Health Status

Among the clinically assessed oral health variables, the number of decayed teeth and the Oral Hygiene Index were significantly and negatively related to children's dental use in bivariate analyses. Those children with more decayed teeth and poorer oral hygiene were less likely to use dental services (see App. Table A.16), but spent more on dental

[7] Appendix Tables A.16 and A.17 present results from bivariate and multivariate analyses designed to identify the subset of variables that best represented each explanatory category in analyses of the probability of children's dental use and of expenditures by users.

Table 10

SUMMARY OF RESULTS: VARIABLES THAT BEST REPRESENT EXPLANATORY CATEGORIES IN ANALYSES OF CHILDREN'S DENTAL UTILIZATION[a]

Explanatory Category/Variable	Bivariate		Multivariate	
	Probability	Expenditures	Probability	Expenditures
Oral Health Status			S	S
DMF28_D*†	–	+	–	+
DMF28_M				
DMF28_F†				
Oral Hygiene Index*†	–	+	–	
Bleeding gums*	–		–	
Wears braces				
Dental pain				
Parent's Perceptions of Child's General Health[b]			S	S
Current health*†	+			
EGFP*†	+	–		
Prior health				
Resistance to illness*†		+	–	+
Parent's Attitudes Toward Dental Care[b]		S		
Availability/Convenience*	+		+	
Access	+			
Cost of Care*				
Pain Management*	+		+	
Technical Quality	+			
General Satisfaction*	+		+	
Parent's Health-Related Knowledge[b]				
Consumer Sophistication*†	+			
Parent's Health-Related Beliefs and Attitudes[b]				S
Efficacy of Self-Care*	+			
Efficacy of Doctor's Care†				
Doctor's Mistakes†				+
Belief in Role of Chance*				
Attitude Toward Going to the Doctor*				
Parent's Health-Related Worry and Concern[b]			S	S
Health worry		–		–
Health concern*	–		–	
Sickness orientation				

Table 10—continued

Explanatory Category/Variable	Bivariate		Multivariate	
	Probability	Expenditures	Probability	Expenditures
Continuity of Dental Care				
Continuity*†	+	−		
Sociodemographics				
Age*†		+	−	
Gender (female)*†				
Ethnicity (black)*†	−	+	−	+
< 12 years education[b]*†	−	+	−	+
Some college[b]*†			−	
College graduate[b]*†	+	−	+	
Family income*†	+			
Missing income*†	−		−	−
Family size	−	+		
Fitchburg				
Franklin County	+	−		
Charleston	−			
Georgetown County	−			
Site*†	−	−		−
Coinsurance 25%*†			−	
Coinsurance 50%*†	−		−	
Coinsurance 95%*†	−		−	
Individual deductible*†	−	−	−	−
Birth order (first)	−	+		
AFDC	−			
AFDC missing				
Number of family heads*	+	−	+	
Married[b]†	−	−		−
Employed[b]*†		+		+

[a]Key to table entries:

S indicates subset of variables that best represented the explanatory category and was significant in explaining utilization definition.

+ indicates the variable defined in that row had a significant and positive relationship with the utilization definition.

− indicates the variable defined in that row had a significant and negative relationship with the utilization definition.

* indicates variable was retained to explain probability of use.

† indicates variable was retained to explain expenditures by users.

[b]Scores on these variables came from the family's medical care decisionmaker, usually the female head.

services when they did use them (see App. Table A.17). Among the oral health measures based on parental report, only bleeding gums was significant; those whose parents reported they had bleeding gums were less likely to use these services (see App. Table A.16).

Number of decayed teeth, the Oral Hygiene Index, and presence (vs. absence) of bleeding gums were retained to predict probability of children's use (see App. Table A.16). All three variables were significantly related in the multivariate analysis, again indicating that children in poorer oral health were *less* likely to obtain care.

In addition to the number of decayed teeth and the Oral Hygiene Index, the number of filled teeth was also retained to predict expenditures on dental services by users (see App. Table A.17). This set was significantly related to expenditures, entirely because of the strong relationship between decay and dental expenditures; users with more decayed teeth spent more.

Parent's Perceptions of Child's General Health

In bivariate analyses, children whose parents perceived them to be in poorer current health were significantly less likely to use dental care (see App. Table A.16). Those whose parents rated their health less favorably on the "excellent/good/fair/poor" (EGFP) measure were also significantly less likely to use dental services, while users spent more on dental services (App. Table A.17). Perceived resistance (rather than susceptibility) to illness on the child's part was positively related to expenditures on dental care by users. Perceptions of the child's previous health were unrelated to dental utilization.

Three variables—Current Health, EGFP, and Resistance to Illness—were retained to explain probability of use by children; the same three were retained in the expenditure equation (see Table 10). This set was significantly related to both definitions of utilization, due in both cases to the relationship between Resistance to Illness and use. Children perceived by their parents to be more resistant to illness were *less* likely to use dental services; by contrast, users who were perceived to be more resistant spent *more* on dental care.

Parent's Satisfaction with Dental Care

Bivariate analyses suggested that parent's satisfaction with dental care correlated significantly only with the probability that the child would use dental services. Children were significantly less likely to use dental services if their parents had less favorable attitudes toward accessibility, availability, and convenience of services, the dentist's

management of pain, and technical quality of care (see App. Table A.16). None of the satisfaction measures was significantly related to expenditures for children in bivariate analyses (see App. Table A.17).

Given these results, multivariate analyses to identify the best subset of satisfaction measures were done only for the probability equation. On the basis of multivariate analyses, four measures were retained in the satisfaction category to explain probability of use: Cost of Care, Availability/Convenience, Pain Management, and General Satisfaction. This subset was significantly related to probability of use; all variables but Cost of Care had significant and positive coefficients, again indicating that children whose parents were less satisfied with their own dental care were less likely to use dental care themselves.

Parent's Health-Related Knowledge[8]

Consumer knowledge about the medical care system related significantly only to the probability of dental use; children with less knowledgeable medical care decisionmakers were less likely to use such services.

Parent's Health-Related Beliefs and Attitudes

In bivariate analyses, only one variable in this category was significantly related to either definition of children's utilization. Children whose parents believed less in the efficacy of self-care were significantly less likely to use services (see App. Table A.16). None was related to expenditures by users (see App. Table A.17).

On the basis of preliminary multivariate analyses, three variables were retained to explain probability of use; these included Efficacy of Self-Care, Belief in the Role of Chance, and Attitude Toward Going to the Doctor. The significant relationship between this subset of explanatory variables and probability of use disappeared, however, when intrafamily correlations were taken into account (see Table 10).

Similarly, two variables—Efficacy of Doctor's Care and Doctor's Mistakes—were retained on the basis of the preliminary multivariate analyses to explain dental expenditures for children (see App. Table A.17). This subset was significantly related to expenditures, reflecting the positive relationship between expenditures and parent's beliefs that doctors make mistakes.

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[8]We had only one measure in this explanatory category; thus, there was no need for multivariate analyses.

Parent's Health-Related Worry and Concern

In bivariate analyses, children of parents who were more concerned about their children's health were significantly less likely to obtain dental care. The user whose parent was more worried about the child's health spent less on dental care.

The build-up and build-down analyses indicated that only Concern should be retained to represent this category in explaining probability of use. We kept both Concern and Worry in the expenditure equation; as in the bivariate analyses, the significance of this subset was due to the negative relationship between worry and expenditures.

Continuity[9]

Children whose families reported not having a regular dentist were significantly less likely to use dental care. By contrast, users with continuity spent less on dental services.

Sociodemographic Characteristics

Among the traditional sociodemographic variables, ethnicity, family size, family income, and marital status and educational attainment (of the medical care decisionmaker, usually the female head) were significantly related in bivariate analyses to the likelihood that a child would use dental services (see App. Table A.16). Black children, those from larger and lower-income families, and those with less educated and unmarried female heads were less likely to use dental care. In addition, the child's birth order, number of family heads, and AFDC status were also significantly related to the probability of use. First-born children, those with single family heads, and those in families receiving AFDC at enrollment were less likely to use dental services.

Ethnicity, family size, and marital status and educational attainment of the female head were significantly related to expenditures by children who used care (see App. Table A.17). Except for ethnicity, the relationships between these variables and expenditures were opposite to those observed for probability of use. Black children, those from larger families, and those with less well-educated and unmarried female heads spent more on dental care. We also noted significant bivariate relationships between expenditures and the child's birth order, number of family heads, and age. First-born and older children spent more on dental services when they used them, and those in single-head families spent less on dental services.

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[9]We had only one measure in this explanatory category; thus, there was no need for multivariate analyses.

As has been reported in previous analyses of the HIE data, children with less generous dental health insurance were less likely to obtain dental care (Manning et al., 1985, 1986). Apart from a negative effect of the individual deductible plan (relative to the free plan), coinsurance did not affect dental expenditures for children in bivariate analyses (see App. Table A.17).

Among the variables considered for inclusion or exclusion, two were retained (along with the entire set used by Manning et al., 1985) to define the sociodemographics category in explaining probability of children's use. These included number of family heads and employment status of the medical-care decisionmaker. When the final multivariate analysis was done, only number of family heads was significantly (and negatively) related to decreased likelihood of use.

From the candidates for addition or exclusion, we kept both employment status and marital status for the expenditure equation. Each made a significant incremental contribution to explaining expenditures by children who used services, and the directions of these relationships were the same as those observed in bivariate analyses.

Summary

Support for our hypotheses regarding the explanatory factors for children's utilization was generally weaker than observed in analyses of adults' utilization, because far fewer variables were significantly related to children's utilization. To summarize our findings:

- For the clinically assessed oral health variables, our hypotheses were confirmed. Children in poorer health status were less likely to use dental services; when they did obtain care, those with decayed teeth in particular spent more. Among the oral health measures reported by the parent, only presence of bleeding gums was related to the probability of use (but not expenditures). As with the clinically assessed variables, this relationship indicated that children in poorer oral health by parental report were less likely to obtain care.
- Findings regarding relationships between parental perceptions of children's general health and utilization weakly confirmed our hypothesis for probability of care, but not for expenditures. Perceived resistance to illness dominated this explanatory category. Parental perceptions of greater resistance were associated with a smaller probability of getting care, but larger expenses once care was obtained.

- We observed the expected association between parental satisfaction with own dental care and children's utilization only for the probability of dental care use. Children of parents who were less satisfied with their own dental care were significantly less likely to obtain services. Contrary to our hypothesis, expenditures by users and parental satisfaction were unrelated.
- As expected, parental knowledge of the medical care system was significantly related to the probability that children would obtain services. Those with less knowledgeable parents were less likely to get dental care. Again contrary to our hypothesis, expenditures by users and parental knowledge were unrelated.
- Findings contradicted our hypothesis with regard to the influence of parents' health-related beliefs and attitudes on children's dental utilization. This explanatory category was unrelated to the probability that children would obtain care. Moreover, children of parents who believed more strongly that doctors make mistakes spent more once they obtained dental services.
- Our findings regarding the relationship between dental continuity and utilization by children replicated those observed for adults and confirmed our hypothesis. Those whose parents reported less provider continuity were less likely to use dental care. Although not hypothesized, we noted that users whose parents had less provider continuity spent more.

The preceding summary indicates that most categories were significantly related to at least one component of utilization. Exceptions to this pattern were the absence of significant associations between parent's satisfaction with own dental care and expenditures, between parent's knowledge of the medical care systems and either definition of utilization, and between parent's health-related beliefs and attitudes and probability of children's use.

Finally, few variables in each category provided significant explanatory power, and we observed many differences in the significant variables that best defined each category in explaining probability of use vs. expenditures by users.

V. METHODOLOGICAL ANALYSES

PRE- VS. POSTDICTIVE MODELS

Rationale

Most empirical studies of health services utilization, including dental services, rely on cross-sectional data. Individuals are asked about their *current* health status or attitudes, and to self-report *past* use of services (usually during the preceding year). As a result, analysts using such data actually "postdict," rather than predict (in the case of forecasting subsequent events), the use of services. They use an after-the-fact measure to explain something that occurred before the outcome. Behaviorally, we would expect that oral health status at the beginning of last year would explain or predict use during that year, which would then explain current oral health status. The causal relationship that interests us actually runs in a direction opposite to the one being estimated with the cross-sectional data.

For example, our analyses indicated that those who are in poorer oral health at the beginning of a year and obtain services consume more dental care. After that treatment, the patient's oral health status should improve. Similarly, given patterns of dental care, those who used more dental services in the past year probably received much of it from the same dentist, making an end-of-the year measure of provider continuity a proxy for use during the previous year.

Using a postdictive model, we would expect to get inconsistent estimates of the effects on dental utilization of oral health status and other characteristics (e.g., attitudes toward care) that may be affected by use of dental care. Unfortunately, the sign on the bias is theoretically indeterminate (Manning, Newhouse, and Ware, 1982). We cannot determine *a priori* whether a postdictive model will cause us to over- or underestimate the true effects of an explanatory variable. If the only problem were that today's health measure reflects yesterday's health plus error, postdiction would lead to the usual bias associated with errors-in-variables or measurement error; the postdictive estimate would be biased toward zero. However, if use of dental services affects oral health status at the margin, there is also a simultaneous equations bias, because today's health status also depends on yesterday's use of dental services. In a simple least-squares model, Manning, Newhouse, and Ware (1982) showed that if past use of health services improves health status, this simultaneous equations bias results in a postdictive

estimate biased toward zero. Thus, in the tooth decay example above, we would expect a bias toward zero from both problems with the postdictive model.

However, the bias need not be *toward* zero. The continuity example above illustrates another type of postdiction bias. In the example, the continuity measure is a disguised variant of the dependent variable, akin to a lagged variable. If dental use is positively correlated over time, as with nearly all forms of health utilization, the coefficient on the continuity measure will be biased *away* from zero. The error term for the dependent variable is positively correlated with past utilization, which is positively correlated with the explanatory variable. When the error term is not independent of the explanatory variables, multiple regression methods such as ours yield inconsistent estimates of the response.

Test for Postdiction Bias

To test for postdiction bias, we studied a sample of adult HIE enrollees ages 14 and older in the five-year group who were eligible for insurance benefits throughout the third year of the study and for whom we had complete data on the explanatory variables (n = 1925). We studied utilization during the third year because the health questionnaires self-administered at the beginning and end of that year (unlike those at the beginning and end of the second year) provided scores for almost all explanatory variables. We also restricted this analysis to the five-year sample, the only subgroup for whom the third experimental year was a steady-state year. Thus, the analyses avoid confusing postdiction with transitory demand (see Manning et al., 1985, 1986). Because oral health status was assessed only at enrollment and at exit from the experiment, these variables were not considered in our analysis of postdiction bias. The explanatory variables we considered were those that best represented the following categories: dental satisfaction; general health perceptions; health-related beliefs, knowledge, and attitudes; continuity of care; and sociodemographics.

Sample. The sample averaged 33 years of age and 12.4 years of education; 55 percent were women. Just over 50 percent were employed, 62 percent were married, and family income averaged $14,100 (in 1983 dollars). The average family had 3.7 members. About 9 percent of the sample was nonwhite.

Analytic Methods. Our analyses of postdiction bias used a test related to the one in our earlier work on medical care utilization (Manning, Newhouse, and Ware, 1982). Because nearly all of the response to the explanatory variables we studied was in the probability of use

(see Sec. II), we examined the logit regression model for any use of dental services during the year.

In addition to the sociodemographic characteristics and study design variables (site, insurance plan), which were assessed at enrollment, our analyses included two sets of explanatory variables. The first represented the values of the variables at the beginning of the second experimental year (the predictive variables), and the second, their values at the end of that year (the postdictive variables). If the coefficients of the postdictive variables did not differ significantly from zero, we would conclude they added nothing above and beyond the truly predictive variables. If the postdictive variables contributed significant variance to the explanation of probability of prior dental use, postdiction bias would be evident. As a gross check on postdiction bias, we tested the significance of variance added by the postdictive variables for each explanatory variable category. We also tested individual variables to determine which ones accounted for the observed postdiction bias.

Results. Our data exhibited substantial postdiction bias. Considered together, the postdictive variables added significant explanatory power in the presence of their predictive counterparts ($\chi^2_{13} = 85.23, p < 0.0001$). By comparison, the predictive variables alone were barely significant ($\chi^2_{13} = 18.83, p < 0.10$). Dental satisfaction measures were substantially biased by postdiction ($\chi^2_4 = 25.21, p < 0.0001$), as were the health-related beliefs and attitudes ($\chi^2_4 = 13.81, p < 0.01$), and the continuity measure ($\chi^2_1 = 17.39, p < 0.0001$). As a set, the general health perceptions measures exhibited no significant postdiction bias ($\chi^2_4 = 3.30$).

Looking at individual measures within the explanatory categories (see Table 11), we found that attitude toward pain management and attitude toward accessibility of dental care had positive and significant postdiction biases ($p < 0.01$ and < 0.05, respectively). The postdiction bias in beliefs about the efficacy of doctors was significant and negative ($p < 0.001$).

EFFECTS OF TIME INTERVAL ON EXPLANATORY VARIABLES

Rationale

The second of our methodological analyses explored differences in explanatory power as a function of the length of time over which dental utilization was measured. Most utilization models, like those we

Table 11

POSTDICTION BIAS IN PROBABILITY OF USING DENTAL CARE

Variable	Coefficient[a]	Estimated Standard Deviation	t
Current Health	−.0014	.0047	−0.31
Health Outlook	.0053	.0050	1.06
Resistance to Illness	−.0021	.0049	−0.44
Health-Related Worry	−.0050	.0036	−1.41
Availability/Convenience	.0014	.0043	0.33
Pain Management	.0111	.0037	2.98
Access	.0086	.0041	2.10
General Satisfaction	.0045	.0028	1.59
Efficacy of Self-Care	−.0016	.0046	−0.34
Attitude Toward Going to the Doctor	.0021	.0024	0.91
Doctor's Mistakes	−.0009	.0033	−0.27
Efficacy of Doctor's Care	−.0017	.0048	−3.49
Continuity of Dental Care	.0132	.0032	4.17

[a]Coefficients are estimates of the bias in the logistic regression for any dental use.

studied here, examine annual utilization. This focus on annual utilization often reflects the aggregated nature of the available claims database. Researchers also aggregate to achieve precision, because utilization occurs infrequently for most individuals.

Among the more important explanatory factors in our models were measures of sociodemographic characteristics, which (with the exception of the nonpermanent component of income) are stable traits. Measures of other factors, such as attitudes and oral health, may do an apparently poorer job of explaining subsequent utilization because the concepts are not stable throughout the period during which utilization was observed. In fact, health perceptions and attitudes do change over time, in part because people use dental care services (Bailit et al., 1985). Psychological theory suggests that as the length of the time between assessment of an attitude and behavior lengthens, the explanatory power of the attitudinal measure will decrease (Kiesler, Collins, and Miller, 1969). By analogy, we would hypothesize that the explanatory contribution of perceived health would decline over time.

Tests of Time Interval Effects on Explanation

To test this hypothesis, we studied a sample of adults ages 14 and older who were eligible for insurance benefits throughout the year, used dental services at least once during that year, and had complete data on the explanatory variables (n = 3352). The dependent variables were counts of dental visits in each quarter of the year following measurement of the explanatory variables.[1] The explanatory variables considered in these analyses included perceived oral health status, general health perceptions, satisfaction with dental care, other health-related beliefs, attitude toward going to the doctor,[2] continuity of dental provider, and annual income. All were measured at the beginning of the year during which utilization occurred (the second experimental year). To keep the timeframe constant, we did not study the clinically assessed or self-report oral health measures or the knowledge variable, which were collected at enrollment (roughly twelve months before the second year began).

Sample. The sample studied in these analyses was a subset of the one used in the adult modeling analyses (see Sec. II). The sample for these analyses averaged 33 years of age and 12 years of education; 54 percent were women. Some 64 percent were employed, 67 percent were married, and family income averaged $13,633 (in 1983 dollars). The average family had 3.8 members, and about 15 percent of the sample was nonwhite.

Analytic Methods. In preliminary analyses, we examined simple correlations between each explanatory variable and each of the quarterly visit counts to see if any trends in the magnitude of the relationships across quarters were readily apparent. For more precise tests, we turned to multiple regression models. In directional terms, we had hypothesized that the coefficients on explanatory variables for use in quarter 1 would be larger (in absolute value) than for use in quarter 4. The corresponding null hypothesis stated that coefficients for the quarter 1 and quarter 4 models would be equal, or that their difference would be zero. A direct comparison of the coefficients across models of different quarters was problematic, since this comparison assumes independence of observations. We observed the same sample in each quarter, however, and utilization correlates over time.

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[1]We used counts because our major test relied on the dependent variable following a Poisson or negative binomial distribution, as do counts of services.

[2]We had included attitudes toward going to the doctor in the Health-Related Beliefs, Knowledge, and Attitudes category in earlier analyses (see Sec. II). We split it out so this category would include only beliefs measures; the knowledge variable was not available for this analysis (see text).

Thus, the two tests we used to examine these hypotheses modeled changes in utilization as a function of time. The advantage of both tests was that each person acted as his own control, thus netting out the intra-individual correlation in use over time. These tests came from a general class of models that state that change in the dependent variable is a function of change in the independent variable (a measured change in an explanatory factor) or change in the relationship of the dependent and independent variable (a change in the coefficient). Because we had only a single observation on each explanatory variable, the independent variables were identical from quarter to quarter. Thus, our models of differences in utilization across quarters actually tested the change in the relationship of utilization and the explanatory variables from quarter to quarter.

The first test was distribution-free; we regressed the difference in use between quarters (e.g., quarter 1 use – quarter 4 use) on the explanatory variables and tested whether the estimated coefficients (in the form β_1–β_4) were significantly different from zero. By taking the first difference, we transformed the two badly skewed visit counts into one roughly symmetric (albeit kurtotic) variable. Given the kurtosis, we tested the sensitivity of the results using robust regression methods (Huber, 1967).

The second test was a distribution-specific test and assumed that the visit count for each adult followed a Poisson distribution. We estimated a negative binomial regression model with population weight equal to the sum of visits in the intervals under consideration (e.g., quarter 1 use + quarter 4 use) and the dependent variable was the ratio of visits in one quarter to this sum (e.g., quarter 1/(quarter 1 + quarter 4)). The negative binomial distribution is a generalization of the Poisson distribution, and this model had been used successfully in previous HIE analyses of dental visits and episodes of treatment (Manning et al., 1985, 1986).

Results

Table 12 presents descriptive statistics for the quarterly counts of dental visits made by adults during the experiment's second year. These data suggest that use on average was quite similar across quarters. Somewhat more visits appear to have been made during the first and fourth quarters; the higher maximum number of visits in the

fourth quarter suggests that some individuals were making visits before the end of the insurance year.[3]

Correlations between quarterly visit counts appear in Table 13. The similar correlations along the diagonal suggest that use was relatively stable across adjacent quarters. Across quarters, use in quarters 1 and 4 was least correlated, as expected.

Correlations between explanatory variables and the quarterly visit counts appear in Table 14. The scalar measure appears in the first row of each category, followed by the variables used to score the scalar; three categories (continuity, attitude toward going to the doctor, family income) each included only one measured variable. Among the scalars, only three showed significant relationships with visit counts in two or more quarters. Attitudes toward dental care were significantly and positively related to visits in the second and fourth quarters; there is no consistent pattern in the magnitude of the correlations. Family income was significantly related to use in all quarters; if anything, there appears to be a slight increase in the relationship between income and use across quarters. Also contrary to our hypothesis, continuity showed a significant and increasingly large correlation with use across quarters.

Among the individual variables, only three showed significant relationships with visit counts in two or more quarters. Only the relationship between beliefs in the efficacy of self-care and utilization showed the expected decrease in magnitude from quarter 1 to quarter 4; all correlations were significantly greater than zero. The relationship between attitude toward access to care and use remained significant

Table 12

DESCRIPTIVE STATISTICS, QUARTERLY DENTAL VISIT COUNTS
(n = 3705)

Quarter	Mean	Standard Deviation	Minimum	Maximum
1	0.46	0.98	0	8
2	0.43	0.92	0	10
3	0.42	0.91	0	8
4	0.47	1.03	0	14

[3]The 12-month period over which visits were observed began when the health questionnaire was returned and thus did not exactly match the insurance year, which began on the family's anniversary of study enrollment.

Table 13

CORRELATIONS BETWEEN QUARTERLY COUNTS OF DENTAL VISITS[a]
(n = 3705)

	Quarter			
Quarter	1	2	3	4
1	—			
2	.23	—		
3	.16	.19	—	
4	.09	.14	.21	—

[a]All correlations significant at $p < 0.0001$.

and essentially unchanged across quarters; that with attitude toward availability/convenience also remained (with the exception of quarter 3) fairly stable.

Results from negative binomial regression analyses that used the scalars to explain visit counts in the first and fourth quarters appear in Tables 15 and 16, respectively. For comparison, results from the regression to explain the annual count of visits appear in Table 17. (Results for quarters 2 and 3 appear in App. Tables A.19 and A.20.) There is little evidence to support the hypothesis that explanatory power decreased as the distance between measurement of explanatory variables and observation of use increased. Most variables had insignificant explanatory effects in all quarters. With one exception (the second quarter; see App. Table A.19), annual family income added significantly. Contrary to our hypothesis, continuity shifted from insignificance to significance as the observation period lengthened.

Results of the formal tests of our hypothesis appear in Tables 18 (distribution-free) and 19 (distribution-specific). In both cases, we tested the null hypothesis: The coefficients for quarters 1 and 4 are equal. Based on the results of these tests, we failed to reject the null hypothesis; we had no evidence of any significant decrement in explanatory power for the scalar definition of any explanatory category with longer intervals between their measurement and use of services. Given this finding, we decided not to pursue analyses of individual variables within the multi-measure categories.

Table 14

CORRELATIONS BETWEEN EXPLANATORY VARIABLES AND COUNTS OF DENTAL VISITS, BY QUARTER[a]

Explanatory Category/Variable	Quarter 1	2	3	4
General Health Perceptions				
Scalar	.002	.031	−.007	.009
Current health	.010	.015	−.026	.001
Health outlook	.002	.031	−.007	.009
Resistance to illness	−.033	.013	−.008	−.006
Health worry	.014	−.004	.033[b]	.017
Satisfaction with Dental Care				
Scalar	.053[b]	.057[d]	.029	.038[b]
Availability/convenience	.048[c]	.055[c]	.020	.073[e]
Access to care	.054[c]	.052[c]	.045[c]	.040[b]
Pain management	.017	.033	.021	.002
Cost of care	.008	.004	−.006	−.001
General satisfaction (residualized)	.029	.005	−.009	−.042[b]
Health-Related Beliefs				
Scalar	−.049[c]	−.021	−.032	−.015
Efficacy of self-care	−.079[e]	−.049[c]	−.051[c]	−.030
Efficacy of doctor's care	−.001	−.029	−.014	−.013
Doctor's mistakes	.006	−.023	−.023	−.012
Attitude Toward Going to the Doctor	.035[b]	.023	−.018	.017
Continuity of Dental Care	.053[c]	.047[c]	.061[d]	.072[e]
Family Income	.054[d]	.034[b]	.079[e]	.059[d]

[a]Sample sizes ranged from 2825 to 3573.
[b]$p < .05$.
[c]$p < .01$.
[d]$p < .001$.
[e]$p < .0001$.

Table 15

PREDICTING FIRST QUARTER DENTAL VISIT COUNTS: NEGATIVE BINOMIAL REGRESSION RESULTS

Explanatory Category	Coefficient	Standard Deviation (Coeff)	t	Co-linear
Intercept	1.0331	0.3267	3.16	0.00
General health perceptions	0.0001	0.0001	−1.19	0.08
Satisfaction with dental care	0.0003	0.0032	−1.03	0.19
Health-related beliefs	−0.0060	0.0032	−1.86	0.11
Attitude toward going to doctor	0.0022	0.0012	1.77	0.05
Continuity	0.0036	0.0020	1.75	0.11
Family income	0.00001	0.0000	2.97	0.05

Table 16

PREDICTING FOURTH QUARTER DENTAL VISIT COUNTS: NEGATIVE BINOMIAL REGRESSION RESULTS

Explanatory Category	Coefficient	Standard Deviation (Coeff)	t	Co-linear
Intercept	0.7859	0.3175	2.48	0.00
General health perceptions	0.0000	0.0001	−0.30	0.04
Satisfaction with dental care	0.0009	0.0031	0.28	0.07
Health-related beliefs	−0.0015	0.0033	−0.44	0.10
Attitude toward going to doctor	0.0007	0.0013	0.51	0.07
Continuity	0.0069	0.0021	3.31	0.15
Family income	0.00001	0.0000	2.58	0.03

Table 17

PREDICTION OF ANNUAL VISIT COUNTS: NEGATIVE BINOMIAL REGRESSION RESULTS

Explanatory Category	Coefficient	Deviation (Coeff)	t	Co-linear
Intercept	0.2227	0.1922	1.16	0.00
General health perceptions	−0.0000	0.0000	−0.63	0.05
Satisfaction with dental care	0.0026	0.0019	1.35	0.13
Health-related beliefs	−0.0029	0.0020	−1.45	0.10
Attitude toward going to doctor	0.0003	0.0008	0.52	0.06
Continuity	0.0045	0.0012	3.58	0.10
Family income	0.00001	0.0000	4.59	0.03

Table 18

DIFFERENCE IN MODELS BETWEEN FIRST AND FOURTH QUARTERS: WEIGHTED LEAST SQUARES REGRESSION RESULTS

Explanatory Category	Coefficient	Standard Deviation (Coeff)	t
Intercept	0.2956	0.3654	−0.81
General health perceptions	−0.0001	0.0001	−0.91
Satisfaction with dental care	−0.0050	0.0040	−1.26
Health-related beliefs	−0.0007	0.0040	−0.18
Attitude toward going to doctor	0.0009	0.0016	0.60
Continuity	0.0037	0.0024	1.54
Family income	0.00001	0.0000	1.63

Table 19

DIFFERENCE IN MODEL BETWEEN FIRST AND FOURTH QUARTERS: LOGIT REGRESSION RESULTS

Explanatory Category	Coefficient	Standard Deviation (Coeff)	t
Intercept	−0.3010	0.2916	−1.03
General health perceptions	0.00009	0.0001	0.88
Satisfaction with dental care	−0.0023	0.0031	−0.74
Health-related beliefs	0.0040	0.0032	1.24
Attitude toward going to doctor	−0.0015	0.0012	−1.20
Continuity	0.0034	0.0018	1.87
Family income	−0.0000	0.0000	−0.21

VI. DISCUSSION

Most people have treatable dental disease, yet about half the U.S. population does not visit a dentist annually (Andersen et al., 1972; Anderson, 1957; National Center for Health Statistics, 1982a; Manning et al., 1985, 1986). Untreated disease is more common among the poor, black, and less educated, who make only half as many visits as their more advantaged counterparts (National Center for Health Statistics, 1981, 1982a, 1986).

Interest in explaining these facts prompted the current research. Studies of utilization behavior generally have focused on one of five categories of variables:

- Oral health status,
- Economic and sociodemographic characteristics,
- Psychological factors,
- Geographic and community characteristics, and
- Organizational features of care.

Table 20 summarizes major studies of dental utilization behavior in terms of the explanatory categories each considered.

Theoretical formulations of utilization (cf. Andersen and Anderson, 1979; Andersen and Newman, 1973; McKinlay, 1972) posit that these factors together affect whether and how much individuals use services. Few earlier studies of dental utilization, however, have been able to examine two or more of these explanatory categories. When several categories were studied, multivariate analytic techniques have been infrequently used.

The prospective database developed during the Health Insurance Experiment included variables in all explanatory categories and thus offered an opportunity to examine the unique and combined influences of explanatory factors on dental utilization behavior. Our analyses were designed to address three questions of primary interest:

- What explains the substantial percentage of people with dental health insurance who do not make any use of dental care during a year?
- What underlying (and usually unmeasured) differences in health status, attitudes, and continuity of care manifest themselves as observed sociodemographic group variations in use of dental care?

Table 20

SELECTED STUDIES OF DENTAL UTILIZATION BEHAVIOR

Explanatory Category	Authors
Oral health status	American Dental Association, 1979; Antonovsky and Kats, 1970; Hay, Bailit, and Chiriboga, 1982; Health Resources Administration, 1979; Kravits and Schneider, 1975; Newman, 1971; Newman and Anderson, 1972; Suchman and Rothman, 1969; Tash, O'Shea, and Cohen, 1969
Economic and sociodemographic characteristics	Aday, Anderson, and Fleming, 1980; Anderson, 1957; Butler, 1967; Douglass and Cole, 1979; Elliott, 1972; Garcia and Juarez, 1978; Kravits and Schneider, 1975; Leverett and Jong, 1980; National Center for Health Statistics, 1982a; Newman, 1971; Okada and Sparer, 1976
Psychological factors	American Dental Association, 1979; Bailit and Raskin, 1978; Bene, Novasky, and Geldart, 1974; Frazier, 1977; Kegeles, 1963a,b; Kravits and Schneider, 1975; Murray and Wiese, 1975; Nikias, 1969; Suchman and Rothman, 1969; Tash, O'Shea, and Cohen, 1969
Geographic and community characteristics	Aday, Anderson, and Fleming, 1980; Alvesalo et al., 1982; Douglas et al., 1971; Douglass and Cole, 1979; Elliott, 1972; Gift, 1981; Okada and Sparer, 1976; Upton and Silverman, 1972
Organizational features	Aday, Anderson, and Fleming, 1980; Andersen and Aday, 1978; Douglass and Cole, 1979; Holtmann and Olsen, 1976; Kronenfeld, 1978, 1979; Manning et al., 1985; Nikias, 1969; Okada and Wan, 1979; Praiss et al., 1979; Rosen, Sussman, and Sussman, 1978; Rossiter, 1982; Salkever, 1976; Schoen, 1973, 1974

- Do the same or different factors account for care-seeking behavior and for amount of care once an individual enters the system?

In addition, we wanted to explore two methodological issues that could affect conclusions regarding what factors explain dental utilization. These included comparisons of predictive with "postdictive" models, and the effect of the interval between collecting explanatory variables and observing utilization on conclusions about their relationships.

EXPLAINING DENTAL CARE UTILIZATION

What Explains Nonuse of Dental Care?

Our analyses of relationships between each of the explanatory categories and utilization indicated, with few exceptions, that each category considered on its own proved useful to understanding whether adults, and children, would use any dental services during the year. In addition to the commonly studied sociodemographic characteristics, we found that oral health status (both clinically assessed and self-reported), perceptions of health in general, health-related beliefs, knowledge, and attitudes, and continuity of dental care were significantly related to probability of use.

The more definitive answer to this question, however, comes from analyses that considered all explanatory factors together, which we did only for adults. Results generally indicated that less likely to use were those who:

- Were in poorer health,
- Had less favorable health-related beliefs and attitudes, and
- Were less likely to have seen the same dentist.

Unexpectedly, analyses that considered all explanatory factors together suggested that satisfaction with dental care services and providers was unrelated to probability of use and expenditures. We discuss this finding in greater detail below.

What Underlying Factors Explain Sociodemographic Group Variations in Adults' Use of Dental Services?

Variations in the probability of using dental care by adults who differed in gender, ethnicity, family size, and geographic site were explained completely by the other explanatory variables we studied. Variations between men and women were accounted for entirely by differences in their oral health; variations in use between blacks and nonblacks were the result of differences in oral health status, health-related beliefs and attitudes, and continuity of dental care.

Variations in use of services across groups differing in age, income, and education were partially explained by the explanatory factors studied. Younger adults were less likely to use services; this finding was explained in part by their better oral health. Lower-income groups were less likely to use dental services in part because they had less continuity of care, poorer health status, and less favorable health-related beliefs and attitudes.

Thus, differences in clinically assessed oral health status appeared to account for much of the observed variation across sociodemographic groups in likelihood of use. Although tempting to conclude that oral health status is the key determinant of whether adults seek dental care during a given year, we believe this conclusion is premature because "oral health status," as operationally defined in this (as in most) studies, is confounded with previous use.

In our studies to select the measures that best represented the oral health status category, two measures in particular had noteworthy relationships with probability of use: the count of filled teeth (DMF28_F) and the need for dental care at the outset of the year (Oral Health, Year 2; see Table 2). The number of filled teeth certainly reflects previous use; teeth are filled only when dental services are used. Moreover, our measure of the need for dental care at the outset of the study's second year was defined to reflect lack of appropriate prior use.

The relationship we have estimated is as much between previous use and subsequent use as it is between oral health status and subsequent use. To understand the unique effects of oral health status at a specified time on subsequent use, the model would require a direct measure of previous use. With the single year of data we used in the analyses of adults' utilization, we cannot discriminate between the true effect of oral health on use and a bias due to an omitted stable trait (the tendency to use the services).

We examined the possibility of capitalizing on the panel dataset available in the HIE to separate these effects. All the approaches we explored were based on the time-series modeling techniques used by Durbin (1960) and other econometricians, which require a stable response over at least a two-year period. Given the large surge in demand for dental care observed during the first year and again during the last year of the HIE induced by changes in dental health insurance coverage, we could not use these modeling techniques with data from the three-year sample. The five-year sample, considerably smaller than the three-year group, would not have provided adequate precision to distinguish the effects of oral health status alone from those of previous use. Until data from a multi-year panel study are available to address this issue, our results should be interpreted as indicating at least three factors are important to understanding nonuse of dental care: poor oral health status, less favorable health-related beliefs and attitudes, and less continuity of dental provider.

Differences in Factors that Explain Probability of Use vs. Expenditures

For statistical reasons, it is useful to study models that estimate independently the probability of utilization and the level of expenditures among those who obtain care, i.e., conditional on use (Duan et al., 1982; Manning et al., 1985, 1986; Rossiter, 1982). Our results underscore the value of disaggregating dental utilization into its component parts and examining the factors that explain each independently.

First, more of the explanatory variables we considered had significant relationships with the probability of use than with expenditures by users. With the exception of the sociodemographic characteristics and clinically assessed oral health status, all other measures were self- (or proxy-) reports, and captured attitudes and beliefs about care and perceptions of overall health. This finding supports the argument that individual differences affect the probability of use more than level of use once the person obtains care.

Second, our analyses indicated differences in the definition of explanatory categories across the two components of utilization. For example, we noted for adults that less favorable attitudes toward the physical availability and accessibility of dental services contributed to explaining the probability of nonuse, while attitudes toward financial access (costs of care) helped explain expenditures by adult users. Similarly, perceptions of poor health in the future dominated the general health perceptions category in explaining lower probability of using care, while health-related worry was instrumental in explaining greater expenditures by users.

Third, our results indicate that conclusions based on models of expenditures per person, which confound the probability and conditional components of use, can lead to erroneous conclusions about the importance and direction of factors that explain use. For example, the analysis of per-person expenditures by adults indicated that neither perceived need for cleaning nor oral health status at the outset of the year were significant explanatory variables. This finding arose, however, because the significant negative effect of these two variables on probability of use was canceled by their significant positive effect on expenditures by users. Similarly, all other things equal, women were significantly more likely to use dental services but spent less when they obtained care, so the net effect of gender on per-person expenditures was negligible.

Finally, those who used preventive dental care represent the majority of adults who used any care, while expenditures on illness-related

services accounted for most of total dental care expenditures by adults. Thus, the differences we noted in definitions of explanatory categories and in the importance of the categories across probability and expenditure definitions also illustrate differences between models that explain use of health- and illness-related dental care.

Comparing Models of Use by Children and by Adults

Direct comparisons between explanatory models for adults and children are complicated by differences in the definition of explanatory variables, data sources (self vs. proxy), sample size, and statistical problems (e.g., the strong correlation among children in the same family in the propensity to use services). Although the magnitude of zero-order correlations between variables in several explanatory categories (e.g., satisfaction with dental care) was higher in models explaining dental care utilization for children than adults, fewer variables were statistically significant when the correlation of use among children in the same family was considered.

Considering these factors, we noted that the explanatory models of use of dental care services estimated for children and adults yielded similar results for variables the models had in common. In general, fewer variables in each explanatory category were significantly associated with children's utilization, which undoubtedly reflects the smaller sample and thus lower level of precision in these analyses. Significant associations tended to be in the same direction for children and adults. An interesting exception was observed for beliefs in the efficacy of self-care. Children of parents with stronger beliefs in the efficacy of self-care were more likely to use services, while adults with such beliefs were less likely to use them. Although this may be a chance result, it may also reflect an important difference in the role of parental health beliefs in determining their children's utilization behavior compared with their own.

For all children younger than 14 years, measures of dental care attitudes, health perceptions, and other explanatory variables reflected parental perceptions about either the child or the parent's care. The value to utilization models of surveying children younger than 14 years directly about their own attitudes and perceptions warrants further study (Eisen et al., 1980).

Value of Attitudinal Measures

To the best of our knowledge, our analyses provided the first opportunity for a prospective evaluation of the validity of attitudes toward health and dental care in relation to subsequent use of dental services. We expected that those with less favorable attitudes would be less likely to seek care.

Our hypothesis was supported for many of the health-related beliefs and attitudes variables in all models of adults' utilization, and for the dental satisfaction variables in all but one model. Measures of attitudes toward specific features of dental care services (availability/convenience of services, access to care, costs of care, pain management, technical quality) and overall satisfaction with dental care were statistically significant, in the hypothesized direction, in zero-order correlations with the probability that adults would use dental care services. Attitudes toward access and technical quality of services were also significantly related, in the hypothesized direction, to expenditures by users in bivariate analyses. When we tested the multiple measures of dental satisfaction, attitudes toward access to care and satisfaction with care in general remained significantly associated with probability of subsequent use, while attitudes toward costs of care were significantly related to expenditures by adult users.

At first glance, these results suggest that dental care providers whose services are physically accessible and whose style of practice is more satisfying to consumers will experience greater demand for their services than other providers. The issue remains, however, why measures of dental satisfaction proved insignificant when associations among measures of dental care satisfaction *and* measures of general health-related beliefs and attitudes and of continuity of care were considered in multivariate models to predict the probability of use by adults. We suspect that continuity of care, which is closely related both to patient satisfaction and use of services, may account for this result.

The importance of patient satisfaction in relation to continuity of care has been well documented (Breslau and Mortimer, 1981; Marquis, Davies, and Ware, 1983; Mirowsky and Ross, 1983; Ware and Davies, 1983; Ware et al., 1973). Thus, the effects of satisfaction on seeking dental care services may be through its effects on the continuity of the dentist-patient relationship. This explanation is consistent with the results we have observed and with those from other prospective studies of the importance of patient attitudes in determining care-seeking behavior (Manning, Newhouse, and Ware, 1982; Marquis, Davies, and Ware, 1983).

METHODOLOGICAL ISSUES

Research design, scaling and scoring of variables, and analytic methods can be as important as anything else in determining conclusions from analyses such as those reported here. Because some of the contradictions in published results may be explained by differences in research methods, we devoted considerable attention to several methodological issues in the current project.

Bias in "Postdictive" Models of Use

"Postdiction" occurs when explanatory variables measured *after* utilization occurs are used to "forecast" variations in utilization. As demonstrated in our earlier work on health status and attitudinal variables in studies of medical utilization (Manning et al., 1982), the parameters of the postdiction equation provide inconsistent estimates of the desired predictive values. Moreover, the direction of the inconsistency theoretically cannot be determined *a priori*. To the best of our knowledge, this problem has not been previously analyzed for models to explain use of dental services.

Consistent with our findings regarding medical care use, our results here indicated substantial postdiction bias in models of adults' dental use. The bias generally caused us to overestimate the importance of such explanatory variables as satisfaction with dental care, health-related beliefs and attitudes, and continuity of care. For individual variables, however, the direction of the postdiction bias was not always the same. For example, the use of variables measured after utilization occurred enhanced the effects of satisfaction with the dentist's management of pain and toward accessibility of dental care but reduced the importance of beliefs in the efficacy of care.

Our results underscore the importance of reliance on truly predictive models in studies of utilization of dental care services. On the strength of findings reported here, and elsewhere for models of expenditures for general medical care services (Manning, Newhouse, and Ware, 1982), we advise caution when testing hypotheses based on "postdictive" models of utilization of health care services when the intent is to forecast or anticipate subsequent use or nonuse of care.

Effects of Time Lag on Explanatory Variables

For the sake of convenience and to improve precision when utilization behaviors occur infrequently, utilization data are commonly aggregated over rather long intervals of time. Counts of utilizations or

expenditures over one- to three-year periods are typical. With such long forecasting periods, it is reasonable to expect that measures of theoretically relevant concepts may fail to predict subsequent utilization behavior because of their instability.

We found no evidence that the practice of aggregating utilization over a one-year interval biased coefficients for measures in any of the five categories of explanatory variables (satisfaction with dental care, general health perceptions, attitude toward going to a doctor, continuity of dental care, and family income) in analyses of adults' utilization. Results were compared for models that predicted utilization of dental care services during the quarter immediately after assessment of explanatory variables, and during each of the three subsequent quarters (periods beginning three, six, and nine months after assessment of explanatory variables).

Either there was no change in the explanatory variables over time (unlikely) or the more stable component of the explanatory variables accounted for differences in utilization. Recall that the explanatory power (in terms of variance accounted for) was fairly weak for all models estimated. We did not have a great deal of precision for testing this hypothesis and may have missed a real difference. Further, the critical period over which time lag effects do occur may be shorter than that studied here. Deterioration in the explanatory power of attitudinal measures (because of change in attitudes) may occur within the three-month period following their assessment.

Univariate vs. Multivariate Explanatory Models

Another methodological issue with important conceptual implications is that of univariate versus multivariate specifications of the explanatory categories. We consistently observed the superiority of defining explanatory categories with more than one variable when predicting utilization, at least by adults. This finding was not as consistent when we considered the best definition of explanatory categories in models of children's utilization.

This finding may appear somewhat obvious, in that multivariate models generally explain more variance in the outcome of interest than do univariate models. We highlight the finding because it has substantive value; in addition to more explanatory power, multivariate specifications of explanatory categories provide important clues to the models' interpretation that would have been missed had a single variable represented a multidimensional concept. For example, for both dental satisfaction and general health perceptions, formal tests of single- vs. multiple-variable definitions of these categories clearly

favored the latter in models to predict adults' utilization of dental services. This finding is consistent with results from an earlier study of univariate and multivariate specifications of health and health care attitudes in models estimating demand for medical care services in general (Manning, Newhouse, and Ware, 1982).

Thus, our findings underscore the importance of representing each explanatory category with more than one measure in subsequent studies of dental services utilization. They indicate that variables within the same category cannot be considered as alternatives to each other in meaning or explanatory value, and that single-variable definitions to represent multidimensional explanatory factors should be avoided.

Other Methodological Considerations

Given the substantial cost differential between clinical measures of oral health status and self-report survey measures, their relative usefulness in predicting dental care utilization is of great importance. In addition to their lower cost, a good theoretical reason to consider including survey measures is the hypothesis that unfavorable perceptions of oral health may be more likely to lead people to seek care than would their health as clinically judged, because the latter information may not be recognized or valued.

The four self-report measures of oral health analyzed here (and used in previous studies) included perceived need for care, two symptoms (toothaches, bleeding gums), and perceived impact of oral health problems. These measures are fairly crude compared with available measures of perceived general health status. The self-report oral health measures were each scored from responses to a single item; thus, they had marginal reliability. Responses to each item could be classified into very few categories; thus, they were coarse. Despite these constraints on precision, they proved to be significant as a set in multivariate predictions of both the probability of dental care and level of expenditures among those who were treated.

The fact that one or more of the four perceived oral health measures were significant in all utilization equations underscores the importance of oral health perceptions in understanding population differences in demand for dental care services. In addition to their value in predicting dental use, improved measures of perceived oral health status should prove of value in studies of dental care outcomes.

To the best of our knowledge, sound multi-item scales measuring these perceptions have not been published since the HIE chose its measures. We recommend construction of precise survey measures of perceived oral health status analogous to the general health perceptions

measures that have proved useful in studies of medical care utilization (Davies and Ware, 1981; Manning, Newhouse, and Ware, 1982). Dental-specific measures should be developed for use in studies of dental care, including scales to measure oral health worry/concern, oral health outlook, current oral health, and oral health distress. Their availability would broaden the definition of perceived oral health status as well as increasing reliability of measurement.

The measures of general attitudes and beliefs about health care that are currently available also represent substantial improvements over the measures analyzed here, which were chosen in the early 1970s for use in the HIE. For example, the scale measuring belief in the efficacy of self-care analyzed here was based on work by Andersen (1968). Since then, beliefs about personal control over health outcomes have received considerable attention, and improved multi-item scales are now available (e.g., Lau, Hartman, and Ware, 1986; Lau and Ware, 1981; Strickland, 1978; Wallston et al., 1976). Future studies of dental care that include this explanatory category, which our results suggest would be important, should rely on these more recent measures. In addition, we suggest development of dental-specific versions of these newer measures, which may prove even more important as explanatory variables than measures of beliefs and attitudes about health care in general. A scale measuring knowledge of dental care services analogous to the consumer sophistication measure used here (Newhouse, Donald, and Ware, 1981) may also prove useful in future studies.

Similarly, although the DMF28 and its components remain time-honored measures of oral health status by clinical assessment, new measures are available to assess presence and progress of such diseases as periodontitis and gingivitis with greater precision than, for example, Russell's (1969) Periodontal Index. In particular, we recommend consideration of the clinical oral health measures currently being fielded in the National Survey of the Oral Health of Employed Adults.

Finally, simple models assume that effects of explanatory variables are additive and that associations between explanatory and utilization variables are linear. These assumptions, which were tested routinely in this study, were most often correct. However, there were some noteworthy exceptions. Specifically, some tests for interactions among explanatory variables and for nonlinearity were significant. For example, attitude toward the availability of dental resources interacted with dental pain management. Those who rated resources as less available were less likely to seek care; this was even more true for those who also rated pain management unfavorably. The association between attitudes toward access to dental services and utilization of those services was not linear in equations estimating the probability of any dental

care during a given year. Whereas simple additive models and simple linear specifications of explanatory variables are most often correct, our experience in examining the functional form of relationships between these explanatory variables and dental care utilization and formal tests for interactions underscore the potential rewards of thorough examination of assumptions of additivity and linearity.

CONCLUSIONS AND RECOMMENDATIONS

In many respects, our research has raised even more questions than we have answered about factors that explain subsequent use and nonuse of dental services by adults and by children. This summary of our final observations and recommendations is directed toward two audiences: dental health services researchers and those responsible for formulating and implementing dental health policy.

Dental Health Services Research

Children's Utilization. The explanatory models of use of dental care services that we estimated for children and adults yielded similar results for variables the models had in common. Analyses of children's utilization were complicated, however, by poorer precision, which may have caused us to miss important relationships. In addition, we did not go beyond models that examined relationships within explanatory categories to study the relative importance of these categories in explaining children's utilization. Given the paucity of studies to explain children's utilization, we strongly recommend continued work in this area as distinct from work on models of utilization by adults or by the entire population. Recognizing the apparently strong effect of prior use on subsequent use of dental services, better knowledge of why children do and do not use care may allow us to target more appropriately interventions designed to encourage development of dental utilization (as distinct from nonutilization) behaviors. As we noted earlier, future studies of children's utilization should also consider the value of surveying younger children directly about their attitudes and perceptions.

True Predictions of Use. Our results indicate that cross-sectional studies of dental utilization significantly overestimate the explanatory power of dental care attitudes and satisfaction with care, general health beliefs and attitudes, and continuity of care. When the interest is in forecasting or anticipating subsequent utilization behavior, as is usually the case, we caution against testing hypotheses or predicting who will

and will not use dental services based on results from cross-sectional studies, which "postdict" use with measures of explanatory variables collected after utilization has occurred.

Multivariate Models of Explanatory Categories. Our results strongly underscore the importance of using several variables within most explanatory categories. Consistently, across specifications of the probability of utilization of dental care services, levels of use among users, and across models predicting preventive and illness behaviors, we observed the superiority of multivariate specifications of explanatory categories. Thus, we recommend that whenever possible, future studies use more than one variable to define multidimensional explanatory categories (e.g., health, attitudes). The results we presented, particularly for adults, provide information that should be useful when selecting among available variables. Investigators who must rely on single indicators of such multidimensional concepts should proceed cautiously when interpreting their results.

Distinguishing Probability and Intensity of Use. Our results and those reported by others (Rossiter, 1982; Manning et al., 1985, 1986) underscore the importance of developing distinct explanatory models for the probability of dental care in a given year and the level of expenditures among those who receive treatment. The decision to seek care is determined by factors that differ in several respects from factors that determine the level of services received by those who obtain dental care. The common practice of analyzing and explaining total dental utilization or expenditures is likely to be very misleading and should be avoided in future research.

Improved Measures. We strongly recommend development and validation of improved measures of perceived oral health status and of health-related beliefs, attitudes, and knowledge that are specific to dental care. Dental health services research cannot proceed in a meaningful way until substantial improvements are made in available measures. In particular, we suggest development of measures that parallel those we and others have constructed to assess perceptions of health in general (Davies and Ware, 1981; Ware, 1976), knowledge about the medical care system (Newhouse, Donald, and Ware, 1981), beliefs about personal control over health outcomes (e.g., Lau, Hartman, and Ware, 1986; Lau and Ware, 1981), and value placed on health in general (Ware and Young, 1979). Our results based on fairly crude survey measures of oral health status and measures of attitudes, knowledge, and beliefs that referred to medical care or health in general underscore the potential gains in understanding variations in dental use and benefits of dental services that should result from improved measures of these concepts. In addition, we suspect that inclusion of measures

designed to assess value (or lack thereof) placed on oral health and appearance may make a major contribution to our understanding of what motivates people to seek care for themselves and their children.

Panel Study. Finally, because of the response to the experimental treatment, we could not capitalize on the panel data in the HIE to distinguish the unique effects of previous dental utilization and current oral health status on the probability of subsequent utilization. Consideration should therefore be given to designing and fielding a multiyear panel study so this issue can be examined directly. Preceding recommendations regarding disaggregation of utilization, use of multivariate models, improved measurement of explanatory variables, and separate analyses of children's and adults' utilization should be considered in designing the panel study, so it could address many of the questions of interpretation left unanswered by our research.

Dental Health Policy

Our analyses of the factors that influence adults' and children's propensity to use dental services lead us to conclude that there are at least two groups in the population:

- Those who are in poorer oral health, probably because they have not used dental services in the past, and who are unlikely to obtain them in the future; and
- Those who enjoy better oral health, probably reflecting their previous use of care, and who are more likely to obtain services in the future.

Those who use dental services probably continue to use them; those who do not use dental services and who could benefit the most from receiving them are apparently less likely (if ever) to enter the system. Although our database did not allow us to investigate, the latter group probably comprises two subgroups: a small group of those who have *never* visited a dentist, and those who *rarely* use dental services. National data suggest that as of 1983, the most recent published survey, some 10 percent of the U.S. population had never used dental care (National Center for Health Statistics, 1986). Supporting the contention that providers are rational, once a person who needs care enters the system, the amount of care they receive (as indicated by expenditures) is directly related to their oral health. If they obtain dental services, those with more decayed and more missing teeth spend significantly more on their care in a given year.

However, the rationality of a system that provides *no* care to those in the greatest need must be questioned, as indeed many have. The major challenge is to draw those in the poorest oral health, who

apparently have rarely used these services in the past, into the system. Once there, our findings suggest that they will receive care.

How might we use the results from our analyses to design or target interventions to increase the likelihood that such people become more likely to use care when needed? Our results, as do those from many previous studies, certainly indicate the subgroups on which interventions should focus. Because it is difficult operationally to identify those with negative health-related attitudes or without regular dentists, interventions should be directed at characteristics that can be readily identified. In particular, this means policy must direct its attention to the low-income and less-educated groups, as well as to children and parents of children (probably regardless of income and educational status).

Our findings also underscore the fact that although the generosity of dental health insurance influences the propensity to obtain care, it alters but does not break the "most users use, and most nonusers don't" syndrome. Policies designed to reduce or eliminate financial barriers to dental care will probably continue to have an effect only at the margin. They are unlikely to affect the majority of those who demonstrate a marked propensity *not* to obtain care annually.

Our results do suggest that interventions designed to alter perceptual barriers might be considered. These perceptual barriers include:

- Lack of knowledge or strong belief that preventive dental care decreases the incidence of oral disease and that illness-related services can halt the development of painful or unsightly oral conditions, and
- Inaccurate self-assessments (or proxy, in the case of children) of oral health conditions (compared with clinical judgments).

For example, there is good evidence that people view their oral health more favorably than would a clinical evaluation (Giddon et al., 1976; Heloe, 1972; Reisine and Bailit, 1980). Reisine and Bailit (1980) reported that although self- and clinical assessments correlated substantially, somewhat more than 30 percent of adults in very poor oral health (with 15 or more missing teeth or 6+ mm periodontal pockets) rated their oral health as good or excellent. Similarly, our previous analyses of HIE data (Davies, Bailit, and Holtby, 1985) noted significant relationships between self-assessed need for cleaning and both number of decayed teeth and periodontal disease. However, almost 30 percent of those with two or more decayed teeth and almost one-quarter of those with established gingivitis or worse periodontal conditions reported they did not need care.

Our analyses also indicated the importance of provider continuity to the greater likelihood that children and adults would use dental care. We recognize that, as defined, the continuity variable may reflect both continuity and previous use (rather than nonuse), given that people who use services do tend to see the same provider. (Referrals from primary to specialist providers, for example, are less common in dentistry than in medicine.) Users may have better continuity and thus may be more likely to use services.

At issue is not this relationship, but how those who are currently nonusers or who do not have regular providers can be linked with providers. Results from our structural equation model suggest that in the context of the experiment at least, generosity of dental health insurance did not increase continuity for adults (specifically, the tendency to see the same provider on most dental visits). Again, alterations in the financing mechanism alone are not a promising approach to improving the continuity of dental care.

More fruitful might be interventions designed to increase the availability of a defined source of dental care, such as in a prepaid dental plan, which integrates the insurance and service delivery functions. Currently, prepaid "health" plans available through employment benefits rarely include coverage for dental services. In addition, although Medicaid covers dental care for children, many of the capitation arrangements that have been developed for Medicaid eligibles specifically exclude dental benefits, which must still be obtained in the fee-for-service system. Moreover, whether the few prepaid dental plans that have been established actually increased the likelihood of using services has not been examined (Schoen, 1974, 1976). Apart from these targeted interventions, we also need to better understand whether the increasing supply of dentists (National Center for Health Statistics, 1986, Table 74) and the perhaps related increase in advertising of dental services has increased the perceived availability of dental services or the proportion of those who claim a regular dentist.

A critical assumption underlies all suggested interventions: that nothing other than inaccurate perceptions, incorrect beliefs, or lack of regular providers prevents care-seeking. Reduction or elimination of these barriers will probably very little alter the propensity to use dental services of people who place little value on good oral health and appearance (their own or that of their children) (Lau, Hartman, and Ware, 1986; Wallston et al., 1976). As we noted earlier, consideration of the effect of value placed on oral health was beyond the scope of our analyses. Moreover, it has received very little attention in previous research on dental utilization behavior. Policymakers should request and support the attention of the dental health services research community to this and other unresolved research issues.

Appendix

SUPPORTING TABLES

Table A.1

DESCRIPTIVE STATISTICS, EXPLANATORY AND DEPENDENT VARIABLES, FOR EXPLORATORY AND CONFIRMATORY SAMPLES, ADULT UTILIZATION ANALYSES

	Exploratory			Confirmatory		
Category/Variable[a]	Number	Mean	Standard Error	Number	Mean	Standard Error
Dental Utilization						
Probability of any use	1913	0.59	0.01	1792	0.59	0.01
Probability of preventive use	1913	0.53	0.01	1792	0.53	0.01
Probability of illness-related use	1913	0.44	0.01	1792	0.44	0.01
Log dollars, all use	1123	3.99	0.04	1062	4.04	0.04
Log dollars, preventive	1919	2.81	0.02	950	2.82	0.02
Log dollars, illness	844	4.00	0.05	793	4.11	0.06
Oral Health Status						
DMF28_D	1022	2.30	0.10	951	2.43	0.10
DMF28_M	1022	5.55	0.25	951	5.31	0.26
DMF28_F	1022	8.01	0.21	951	8.07	0.22
Periodontal Index	928	1.15	0.02	879	1.16	0.02
Oral health, year 2	918	0.15	0.01	864	0.13	0.01
Oral Hygiene Index	912	1.68	0.04	855	1.67	0.04
Toothache	1759	1.16	0.01	1655	1.17	0.01
Bleeding gums	1079	0.21	0.01	1003	0.23	0.01
Need cleaning	1608	0.61	0.01	1488	0.62	0.01
Impact of dental disease	1602	4.12	0.04	1483	4.09	0.04
General Health Perceptions						
Current health	1815	71.04	0.44	1688	71.46	0.47
Health outlook	1814	66.72	0.39	1687	67.23	0.41
Prior health	1814	70.81	0.63	1687	70.23	0.65
Resistance to illness	1814	70.10	0.40	1687	69.67	0.41
Sickness orientation	1814	56.82	0.58	1687	58.45	0.60
Health worry	1816	34.77	0.48	1689	34.46	0.50
Satisfaction with Dental Care						
Access	1801	54.66	0.43	1668	56.08	0.46
Availability/Convenience	1799	64.67	0.39	1667	64.84	0.42
Pain management	1801	48.93	0.50	1668	50.66	0.52
Cost of care	1800	37.71	0.43	1668	38.55	0.47
Technical quality	1801	62.30	0.28	1668	62.71	0.30
General satisfaction	1799	0.31	0.55	1666	−0.34	0.57

Table A.1—continued

Category/Variable[a]	Exploratory			Confirmatory		
	Number	Mean	Standard Error	Number	Mean	Standard Error
Health-Related Beliefs, Knowledge, and Other Attitudes						
Efficacy of self-care	1847	39.50	0.40	1727	39.17	0.42
Efficacy of doctor's care	1847	66.49	0.33	1726	66.69	0.34
Doctor's mistakes	1845	58.73	0.48	1722	58.32	0.49
Attitude toward going to MD	1814	47.65	0.69	1687	48.93	0.73
Belief in role of chance	1839	47.97	0.56	1718	48.44	0.60
Rejection of patient role	1814	69.97	0.39	1687	70.53	0.40
Consumer sophistication	1465	60.62	0.57	1360	60.32	0.61
Health concern	1814	53.48	0.52	1687	53.92	0.53
Continuity of Care						
Continuity	1633	1.97	0.02	1531	1.99	0.02
Sociodemographics						
Age	1913	33.22	0.29	1792	32.87	0.30
Gender (% female)	1913	0.53	0.01	1792	0.54	0.01
Ethnicity (% black)	1913	0.15	0.01	1792	0.15	0.01
Less than high school (%)	1913	0.29	0.01	1792	0.28	0.01
High school graduate (%)	1913	0.40	0.01	1792	0.38	0.01
Some college (%)	1913	0.17	0.01	1792	0.18	0.01
College graduate (%)	1913	0.14	0.01	1792	0.15	0.01
Family income ($)	1913	13652	157.34	1792	13614	165.15
Missing income (%)	1913	0.08	0.01	1792	0.09	0.01
Employed (%)	1831	0.63	0.01	1736	0.64	0.01
Married (%)	1875	0.64	0.01	1765	0.71	0.01
AFDC (%)	1913	0.06	0.01	1792	0.06	0.01
Missing AFDC (%)	1913	0.02	0.00	1792	0.03	0.00
Insurance plan						
Free plan (%)	1913	0.48	0.01	1792	0.49	0.01
Coinsurance 25% (%)	1913	0.07	0.01	1792	0.06	0.01
Coinsurance 50% (%)	1913	0.12	0.01	1792	0.12	0.01
Coinsurance 95% (%)	1913	0.13	0.01	1792	0.14	0.01
Individual deductible (%)	1913	0.19	0.01	1792	0.19	0.01
Site						
Seattle (%)	1913	0.42	0.01	1792	0.41	0.01
Fitchburg (%)	1913	0.13	0.01	1792	0.11	0.01
Franklin County (%)	1913	0.15	0.01	1792	0.16	0.01
Charleston (%)	1913	0.13	0.01	1792	0.14	0.01
Georgetown County (%)	1913	0.17	0.01	1792	0.18	0.01

[a]See Table 6 for operational definitions of each variable.

In Tables A.2 through A.7, the first pair of columns presents results from bivariate analyses of relationships between each of the explanatory variables we considered and one of the definitions of dental utilization. The remaining columns summarize results from the build-up and build-down analyses. Within each explanatory category, the variables that best represented the category are listed first, followed by the χ^2 (probability) or F-statistic (expenditures) for this subset. Column entries for these variables indicate the sign and t-statistic for the partial correlation in the final logit or OLS regressions in the explanatory and confirmatory samples, respectively. The variables that were excluded from the definition of each explanatory category are listed second.

Table A.2

EXPLAINING PROBABILITY OF ADULTS' USE OF PREVENTIVE DENTAL CARE: RESULTS OF ANALYSES TO SELECT VARIABLES THAT BEST REPRESENT EXPLANATORY CATEGORIES

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Oral Health Status						
Clinically Assessed						
DMF28_D	−.13	<.001	−	0.13	−	1.00
DMF28_M	−.26	<.0001	+	0.03	+	0.67
DMF28_F	.33	<.0001	+	5.63	+	5.11
Periodontal Index	−.24	<.001	−	1.99	−	1.26
Oral health, year 2	−.23	<.0001	−	2.35	−	2.16
χ^{2e}_5			106.01	(p<.0001)	79.81	(p<.0001)
Oral Hygiene Index	−.27	<.0001	—	—	—	—
Common Survey Self-Report Measures						
Bleeding gums	−.10	<.01	−	3.34	−	4.61
Toothache	−.01	NS	−	0.42	−	2.21
χ^2_2			11.66	(p<.01)	29.26	(p<.0001)
Other Self-Report Measures						
Need cleaning	−.05	<.05	−	2.46	−	2.02
Impact of disease	−.01	NS	−	2.37	−	1.54
χ^2_2			14.81	(p<.001)	7.56	(p<.05)
General Health Perceptions						
Current Health	.10	<.0001	+	1.89	+	0.77
Health Outlook	.08	<.001	+	2.34	+	2.17
Resistance to Illness	.02	NS	−	2.89	−	1.58
χ^2_3			17.83	(p<.001)	9.25	(p<.05)
Sickness Orientation	−.01	NS	—	—	—	—
Health Worry	−.06	<.001	—	—	—	—
Prior Health	.04	NS	—	—	—	—
Satisfaction with Dental Care						
Availability/Convenience	.17	<.001	−	0.68	+	1.31
Pain Management	.18	<.001	−	1.50	+	1.16
General Satisfaction	.05	<.01	+	2.04	+	1.72

Table A.2—continued

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Access[2]	—	—	+	2.32	+	2.46
Availability × Pain	—	—	+	2.38	−	0.40
χ^2_5			52.30	(p<.0001)	35.10	(p<.0001)
Cost of Care	.05	<.05	—	—	—	—
Technical Quality	.14	<.0001	—	—	—	—
Health-Related Beliefs, Knowledge, and Other Attitudes						
Efficacy of Self-Care	−.13	<.0001	−	3.26	−	4.87
Doctor's Mistakes	−.06	<.01	−	1.78	+	0.23
Attitude Toward Going to Doctor	.04	NS	+	1.59	+	1.69
Efficacy of Doctor's Care	−.03	NS	−	3.16	−	2.54
χ^2_4			23.49	(p<.001)	30.89	(p<.0001)
Belief in Role of Chance	−.07	<.01	—	—	—	—
Rejection of Patient Role	−.03	NS	—	—	—	—
Consumer Sophistication	.05	NS	—	—	—	—
Health Concern	−.05	<.05	—	—	—	—
Continuity of Care						
Continuity of Dental Care	.20	<.0001	+	7.77	+	7.62
χ^2_1			63.83	(p<.0001)	61.72	(p<.0001)
Sociodemographics						
Age	−.04	NS	−	3.19	−	2.68
Gender (female)	.03	NS	+	4.89	+	3.54
Ethnicity (black)	−.26	<.0001	−	0.77	−	2.57
Less than high school	−.19	<.0001	−	2.70	−	3.78
Some college	.05	<.01	+	1.05	−	0.19
College graduate	.16	<.0001	+	4.99	+	3.66
Family income	.16	<.0001	+	6.58	+	3.75
Missing income	−.12	<.0001	−	2.91	−	0.97
Family size	−.05	<.01	−	2.30	−	0.13
Coinsurance 25%	.00	NS	−	1.54	−	1.66
Coinsurance 50%	−.05	<.01	−	3.46	−	4.19
Coinsurance 95%	−.12	<.0001	−	4.52	−	5.42
Individual deductible	−.05	<.05	−	4.25	−	6.23

Table A.2—continued

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Fitchburg	.00	NS	+	2.19	+	0.32
Franklin County	.10	<.0001	+	4.73	+	3.18
Charleston	−.13	<.0001	−	2.36	−	1.24
Georgetown County	−.11	<.0001	−	1.50	+	0.41
χ^2_{17}			282.86	(p<.0001)	212.19	(p<.0001)
Employed	.00	NS	—	—	—	—
Married	.04	NS	—	—	—	—
AFDC	−.06	<.05	—	—	—	—
Missing AFDC	−.02	NS	—	—	—	—

NOTE: NS = not significant.

[a]Within each category, the rows listed above the test statistic row identify variables that were retained to define the category; those listed after the test statistic row were excluded.

[b]Simple correlation (r) and p-value (p) for relationship between explanatory variable and definition of dental utilization.

[c]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in exploratory sample.

[d]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in confirmatory sample.

[e]Overall χ^2-statistic for retained explanatory variables (in rows immediately above) in the category predicting utilization.

Table A.3

EXPLAINING PROBABILITY OF ADULTS' USE OF ILLNESS-RELATED DENTAL CARE: RESULTS OF ANALYSES TO SELECT VARIABLES THAT BEST REPRESENT EXPLANATORY CATEGORIES

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Oral Health Status						
Clinically Assessed						
DMF28_D	−.03	NS	+	2.63	+	1.60
DMF28_M	−.11	<.01	+	2.33	+	2.57
DMF28_F	.22	<.0001	+	4.93	+	6.02
Periodontal Index	−.12	<.01	−	1.49	+	1.52
Oral health, year 2	−.42	<.0001	−	2.43	−	2.50
χ^2_5[e]			46.91	(p<.0001)	55.42	(p<.0001)
Oral Hygiene Index	−.14	<.0001	—	—	—	—
Common Survey Self-Report Measures						
Bleeding gums	−.05	NS	−	2.58	−	2.53
Toothache	.07	<.001	+	0.76	+	0.96
χ^2_2			7.05	(p<.05)	6.97	(p<.05)
Other Self-Report Measures						
Need cleaning	.02	NS	−	0.41	−	1.69
Impact of disease	.11	<.0001	−	0.06	+	0.97
χ^2_2			0.19	(p>.10)	3.37	(p>.10)
General Health Perceptions						
Current Health	.03	NS	−	0.57	−	0.93
Health Outlook	.03	NS	+	1.66	+	0.28
Resistance to Illness	.00	NS	−	0.44	+	0.05
χ^2_3			2.86	(p>.10)	0.99	(p>.10)
Sickness Orientation	.03	NS	—	—	—	—
Health Worry	−.02	NS	—	—	—	—
Prior Health	.00	NS	—	—	—	—
Satisfaction with Dental Care						
Availability/Convenience	.13	<.0001	−	0.41	+	1.30
Pain Management	.13	<.0001	−	1.10	+	1.37
General Satisfaction	.07	<.0001	+	0.46	+	0.94
Access[2]	—	—	+	1.49	+	3.36
Availability × Pain	—	—	+	1.52	−	1.33
χ^2_7			17.03	(p<.05)	16.68	(p<.05)

Table A.3—continued

Explanatory Category/Variable[a]	Bivariate[b] r	Bivariate[b] p	Multivariate: Exploratory[c] Sign	Multivariate: Exploratory[c] t	Multivariate: Confirmatory[d] Sign	Multivariate: Confirmatory[d] t
Cost of Care	.07	<.001	—	—	—	—
Technical Quality	.15	<.0001	—	—	—	—
Health-Related Beliefs, Knowledge, and Other Attitudes						
Efficacy of Self-Care	−.11	<.0001	−	1.45	−	3.53
Doctor's Mistakes	−.04	NS	−	0.59	+	0.63
Attitude Toward Going to Doctor	.05	<.05	+	1.14	+	1.76
Efficacy of Doctor's Care	.00	NS	−	2.03	−	0.88
χ^2_4			6.55	(p>.10)	17.07	(p<.01)
Belief in Role of Chance	−.05	<.05	—	—	—	—
Rejection of Patient Role	.02	NS	—	—	—	—
Consumer Sophistication	.04	NS	—	—	—	—
Health Concern	−.03	NS	—	—	—	—
Continuity of Care						
Continuity of Dental Care	.20	<.0001	+	5.14	+	4.23
χ^2_1			27.08	(p<.0001)	18.26	(p<.0001)
Sociodemographics						
Age	.04	NS	−	0.85	+	0.79
Gender (female)	.02	NS	+	3.50	+	1.55
Ethnicity (black)	−.18	<.0001	−	1.13	−	0.92
Less than high school	−.12	<.0001	−	0.74	−	0.32
Some college	.05	<.01	+	1.55	−	0.75
College graduate	.03	NS	+	0.79	+	2.59
Family income	.08	<.001	+	3.78	+	1.57
Missing income	−.09	<.0001	−	1.52	−	0.52
Family size	−.05	<.01	−	0.82	+	0.41
Coinsurance 25%	−.03	NS	−	2.73	−	0.68
Coinsurance 50%	−.04	<.05	−	1.87	−	2.94
Coinsurance 95%	−.09	<.0001	−	3.94	−	3.85
Individual deductible	−.04	<.05	−	3.75	−	4.04
Fitchburg	.05	<.01	+	1.11	+	0.78
Franklin County	.05	<.01	+	3.89	+	1.24
Charleston	−.15	<.0001	−	1.72	−	2.12
Georgetown County	−.11	<.0001	−	0.68	−	1.32
χ^2_{17}			111.93	(p<.0001)	77.35	(p<.0001)

Table A.3—continued

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Employed	.00	NS	—	—	—	—
Married	.05	<.01	—	—	—	—
AFDC	−.02	NS	—	—	—	—
Missing AFDC	−.01	NS	—	—	—	—

NOTE: NS = not significant.

[a]Within each category, the rows listed above the test statistic row identify variables that were retained to define the category; those listed after the test statistic row were excluded.

[b]Simple correlation (r) and p-value (p) for relationship between explanatory variable and definition of dental utilization.

[c]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in exploratory sample.

[d]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in confirmatory sample.

[e]Overall χ^2-statistic for retained explanatory variables (in rows immediately above) in the category predicting utilization.

Table A.4

EXPLAINING PROBABILITY OF ADULTS' USE OF ANY DENTAL CARE: RESULTS OF ANALYSES TO SELECT VARIABLES THAT BEST REPRESENT EXPLANATORY CATEGORIES

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Oral Health Status						
Clinically Assessed						
DMF28_D	−.13	<.0001	+	1.48	+	0.04
DMF28_M	−.21	<.0001	+	0.74	+	1.44
DMF28_F	.32	<.0001	+	5.70	+	5.60
Periodontal Index	−.23	<.0001	−	2.50	−	0.89
Oral health, year 2	−.25	<.0001	−	3.43	−	3.02
χ^2_5[e]			107.66	(p<.0001)	82.84	(p<.0001)
Oral Hygiene Index	−.27	<.0001	—	—	—	—
Common Survey Self-Report Measures						
Bleeding gums	−.11	<.01	−	3.94	−	4.83
Toothache	−.01	NS	+	0.13	−	0.58
χ^2_2			15.42	(p<.001)	24.70	(p<.0001)
Other Self-Report Measures						
Need cleaning	−.07	<.001	−	2.49	−	3.31
Impact of disease	−.01	NS	−	1.91	−	0.44
χ^2_2			12.34	(p<.01)	11.96	(p<.01)
General Health Perceptions						
Current Health	.08	<.01	+	1.62	−	0.10
Health Outlook	.06	<.05	+	2.53	+	1.98
Resistance to Illness	.00	NS	−	2.68	−	0.68
χ^2_3			17.18	(p<.001)	5.64	(p>.10)
Sickness Orientation	−.06	<.05	—	—	—	—
Health Worry	−.06	<.05	—	—	—	—
Prior Health	.03	NS	—	—	—	—
Satisfaction with Dental Care						
Availability/Convenience	.17	<.0001	−	.55	+	1.44
Pain Management	.18	<.0001	−	1.48	+	1.00
General Satisfaction	.06	<.01	+	2.62	+	2.46
Access[2]	—	—	+	2.05	+	2.60
Availability × Pain	—	—	+	2.42	−	0.26
χ^2_5			57.44	(p<.0001)	42.76	(p<.0001)

Table A.4—continued

Explanatory Category/Variable[a]	Bivariate[b] r	Bivariate[b] p	Multivariate: Exploratory[c] Sign	Multivariate: Exploratory[c] t	Multivariate: Confirmatory[d] Sign	Multivariate: Confirmatory[d] t
Cost of Care	.05	<.05	—	—	—	—
Technical Quality	.14	<.0001	—	—	—	—
Health-Related Beliefs, Knowledge, and Other Attitudes						
Efficacy of Self-Care	−.14	<.0001	−	3.31	−	5.27
Doctor's Mistakes	−.07	<.001	−	1.26	+	0.30
Attitude Toward Going to Doctor	.05	<.05	+	2.03	+	1.84
Efficacy of Doctor's Care	−.03	NS	−	3.18	−	2.40
χ^2_4			23.38	(p<.001)	35.34	(p<.0001)
Belief in Role of Chance	−.09	<.001	—	—	—	—
Rejection of Patient Role	−.02	NS	—	—	—	—
Consumer Sophistication	.06	<.05	—	—	—	—
Health Concern	−.05	<.05	—	—	—	—
Continuity of Care						
Continuity of Dental Care	.21	<.0001	+	8.68	+	7.32
χ^2_1			80.50	(p<.0001)	56.46	(p<.0001)
Sociodemographics						
Age	.00	NS	−	2.39	−	1.63
Gender (female)	.02	NS	+	4.93	+	3.82
Ethnicity (black)	−.28	<.0001	−	1.33	−	1.82
Less than high school	−.18	<.0001	−	2.03	−	2.48
Some college	.04	<.05	+	1.00	−	0.35
College graduate	.16	<.0001	+	4.46	+	4.49
Family income	.16	<.0001	+	6.10	+	3.88
Missing income	−.11	<.0001	−	2.93	−	1.80
Family size	−.05	<.01	−	2.08	−	0.12
Coinsurance 25%	−.02	NS	−	2.31	−	2.12
Coinsurance 50%	−.04	<.05	−	3.30	−	3.93
Coinsurance 95%	−.10	<.0001	−	4.72	−	5.95
Individual deductible	−.04	NS	−	4.47	−	6.10
Fitchburg	.01	NS	+	1.92	+	0.84
Franklin County	.10	<.0001	+	4.37	+	2.72
Charleston	−.13	<.0001	−	2.61	−	1.60

Table A.4—continued

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Georgetown County	−.12	<.0001	−	1.29	−	0.36
χ^2_5			263.34	(p<.0001)	206.18	(p<.0001)
Married	.05	p<.05	—	—	—	—
Employed	.01	NS	—	—	—	—
AFDC	−.04	NS	—	—	—	—
Missing AFDC	−.01	NS	—	—	—	—

NOTE: NS = not significant.

[a]Within each category, the rows listed above the test statistic row identify variables that were retained to define the category; those listed after the test statistic row were excluded.

[b]Simple correlation (r) and p-value (p) for relationship between explanatory variable and definition of dental utilization.

[c]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in exploratory sample.

[d]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in confirmatory sample.

[e]Overall χ^2-statistic for retained explanatory variables (in rows immediately above) in the category predicting utilization.

Table A.5

EXPLAINING ADULT USERS' EXPENDITURES ON PREVENTIVE DENTAL CARE: RESULTS OF ANALYSES TO SELECT VARIABLES THAT BEST REPRESENT EXPLANATORY CATEGORIES

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Oral Health Status						
Clinically Assessed						
DMF28_D	.02	NS	–	0.13	–	1.20
DMF28_M	–.05	NS	+	0.60	–	0.43
DMF28_F	.12	<.001	+	2.24	+	1.41
Periodontal Index	.11	<.001	+	0.95	+	2.11
Oral health, year 2	.01	NS	+	1.45	+	0.01
$F_{5,516/448}$[e]			1.60	(p>.10)	1.62	(p>.10)
Oral Hygiene Index	.08	NS	—	—	—	—
Common Survey Self-Report Measures						
Bleeding gums	.01	NS	+	0.34	+	1.03
Toothache	.06	NS	+	0.10	–	0.28
$F_{2,505/528}$			0.07	(p>.10)	0.54	(p>.10)
Other Self-Report Measures						
Need cleaning	.13	<.0001	+	1.62	–	0.16
Impact of disease	.09	<.001	–	1.86	+	1.85
$F_{2,922/839}$			2.54	(p<.05)	1.72	(p>.10)
General Health Perceptions						
Health Worry			+	0.33	+	0.67
Health Outlook	.06	NS	+	0.52	+	0.99
Resistance to Illness	.03	NS	–	0.71	–	0.58
$F_{3,986/909}$			0.26	(p>.10)	0.44	(p>.10)
Sickness Orientation	.00	NS	—	—	—	—
Current Health	.02	NS	—	—	—	—
Prior Health	.01	NS	—	—	—	—
Satisfaction with Dental Care						
Cost of Care	–.02	NS	–	1.07	–	1.56
Pain Management	.04	NS	–	0.05	+	1.51
General Satisfaction	–.02	NS	+	0.05	–	1.13
$F_{3,983/895}$			0.41	(p>.10)	1.77	(p>.10)
Access	.09	<.001	—	—	—	—

Table A.5—continued

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Technical Quality	.13	<.0001	—	—	—	—
Availability/Convenience	.01	NS	—	—	—	—
Health-Related Beliefs, Knowledge, and Other Attitudes						
Efficacy of Self-Care	−.05	<.05	−	0.69	−	1.47
Doctor's Mistakes	−.03	NS	−	1.09	+	0.03
Efficacy of Doctor's Care	−.10	<.001	+	0.06	+	0.17
$F_{3,813/733}$			0.77	(p>.10)	0.84	(p>.10)
Belief in Role of Chance	−.02	NS	—	—	—	—
Rejection of Patient Role	.04	NS	—	—	—	—
Consumer Sophistication	.03	NS	—	—	—	—
Health Concern	−.06	<.05	—	—	—	—
Attitude Toward Going to Doctor	−.01	NS	—	—	—	—
Continuity of Care						
Continuity of Dental Care	.01	NS	+	0.32	+	0.14
$F_{1,907/845}$			0.10	(p>.10)	0.02	(p>.10)
Sociodemographics						
Age	−.02	NS	−	0.98	−	1.02
Gender (female)	−.04	NS	−	0.07	−	0.46
Ethnicity (black)	−.02	NS	+	1.62	+	0.01
Less than high school	−.10	<.0001	−	2.59	−	1.14
Some college	.04	NS	+	1.00	−	0.45
College graduate	.01	NS	−	0.13	−	1.07
Family income	.03	NS	−	0.11	−	1.60
Missing income	.02	NS	+	0.22	−	2.48
Family size	−.06	<.01	+	0.60	−	1.66
Coinsurance 25%	−.04	NS	−	1.01	−	1.15
Coinsurance 50%	−.08	<.001	−	1.94	−	1.49
Coinsurance 95%	−.13	<.0001	−	0.17	−	0.28
Individual deductible	−.05	NS	−	2.05	−	1.79
Fitchburg	−.09	<.0001	−	4.49	−	4.09
Franklin County	−.15	<.0001	−	6.46	−	6.09
Charleston	.00	NS	−	2.35	−	2.19

Table A.5—continued

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Georgetown County	−.14	<.0001	−	6.29	−	4.32
$F_{17,961/903}$			6.81	(p<.001)	5.66	(p<.001)
Employed	−.02	NS	—	—	—	—
Married	−.01	NS	—	—	—	—
AFDC	.01	NS	—	—	—	—
Missing AFDC	.02	NS	—	—	—	—

NOTE: NS = not significant.

[a]Within each category, the rows listed above the test statistic row identify variables that were retained to define the category; those listed after the test statistic row were excluded.

[b]Simple correlation (r) and p-value (p) for relationship between explanatory variable and definition of dental utilization.

[c]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in exploratory sample.

[d]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in confirmatory sample.

[e]Overall F-statistic for retained explanatory variables (in rows immediately above) in the category predicting utilization. Degrees of freedom stated as: model, exploratory/confirmatory.

Table A.6

EXPLAINING ADULT USERS' EXPENDITURES ON ILLNESS-RELATED DENTAL CARE: RESULTS OF ANALYSES TO SELECT VARIABLES THAT BEST REPRESENT EXPLANATORY CATEGORIES

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Oral Health Status						
Clinically Assessed						
DMF28_D	.12	<.001	+	3.53	+	2.25
DMF28_M	.10	<.01	+	3.62	+	1.87
DMF28_F	.03	NS	+	5.13	+	2.90
Periodontal Index	.13	<.0001	+	1.67	+	1.46
Oral health, year 2	.09	<.01	+	1.56	+	0.37
$F_{5,414/368}$[e]			9.55	(p<.001)	3.16	(p<.01)
Oral Hygiene Index	.11	<.01	—	—	—	—
Common Survey Self-Report Measures						
Bleeding gums	.09	<.01	+	0.80	+	2.98
Toothache	.01	NS	+	1.66	–	1.89
$F_{2,491/438}$			1.81	(p>.10)	5.54	(p<.001)
Other Self-Report Measures						
Need cleaning	.08	<.01	+	1.47	+	1.32
Impact of disease	.14	<.0001	+	3.40	+	3.40
$F_{2,750/692}$			8.09	(p<.001)	8.01	(p<.001)
General Health Perceptions						
Health Worry	.07	<.01	+	1.85	+	2.08
Health Outlook	.00	NS	+	0.89	+	1.13
Resistance to Illness	–.03	NS	–	0.40	–	0.93
$F_{3,814/753}$			1.47	(p>.10)	2.16	(p>.10)
Sickness Orientation	–.02	NS	—	—	—	—
Current Health	–.08	<.001	—	—	—	—
Prior Health	–.01	NS	—	—	—	—
Satisfaction with Dental Care						
Cost of Care	–.06	<.05	–	0.96	–	1.88
Pain Management	–.07	<.01	–	1.73	–	1.26
General Satisfaction	–.05	<.05	–	0.41	–	2.37
$F_{3,811/743}$			1.67	(p>.10)	4.10	(p<.01)
Access	–.01	NS	—	—	—	—
Technical Quality	.00	NS	—	—	—	—
Availability/Convenience	.02	NS	—	—	—	—

Table A.6—continued

Explanatory Category/Variable[a]	Bivariate[b] r	Bivariate[b] p	Multivariate: Exploratory[c] Sign	Multivariate: Exploratory[c] t	Multivariate: *Confirmatory*[d] Sign	Multivariate: *Confirmatory*[d] t
Health-Related Beliefs, Knowledge, and Other Attitudes						
Efficacy of Self-Care	.02	NS	+	1.12	–	1.43
Doctor's Mistakes	–.02	NS	–	1.61	–	0.05
Efficacy of Doctor's Care	–.01	NS	–	1.28	+	0.51
$F_{3,665/601}$			1.71	(p>.10)	0.97	(p>.10)
Belief in Role of Chance	.01	NS	—	—	—	—
Rejection of Patient Role	.03	NS	—	—	—	—
Consumer Sophistication	.05	NS	—	—	—	—
Health Concern	.00	NS	—	—	—	—
Attitude Toward Going to Doctor	–.03	NS	—	—	—	—
Continuity of Care						
Continuity of Dental Care	–.05	NS	–	1.38	–	1.13
$F_{1,748/696}$			1.90	(p>.10)	1.27	(p>.10)
Sociodemographics						
Age	.06	<.05	+	1.54	+	3.11
Gender (female)	–.01	NS	–	1.85	–	0.02
Ethnicity (black)	.05	<.05	+	1.97	+	0.01
Less than high school	.02	NS	–	1.20	+	0.15
Some college	–.02	NS	–	1.07	+	0.64
College graduate	–.04	NS	–	1.66	–	0.93
Family income	–.03	NS	–	0.95	–	2.43
Missing income	.00	NS	–	1.15	+	0.18
Family size	.01	NS	+	0.42	+	1.79
Coinsurance 25%	–.02	NS	–	0.19	–	0.67
Coinsurance 50%	–.06	<.05	–	0.55	–	1.52
Coinsurance 95%	–.03	NS	–	0.67	–	2.27
Individual deductible	–.03	NS	+	1.11	–	2.51
Fitchburg	–.08	<.001	–	3.91	–	1.77
Franklin County	–.12	<.0001	–	5.38	–	1.74
Charleston	.05	NS	–	0.20	–	0.39
Georgetown County	.00	NS	–	2.09	–	1.10
$F_{17,789/754}$			3.26	(p<.001)	2.28	(p<.01)

Table A.6—continued

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Employed	.00	NS	—	—	—	—
Married	.04	NS	—	—	—	—
AFDC	-.01	NS	—	—	—	—
Missing AFDC	.03	NS	—	—	—	—

NOTE: NS = not significant.

[a]Within each category, the rows listed above the test statistic row identify variables that were retained to define the category; those listed after the test statistic row were excluded.

[b]Simple correlation (r) and p-value (p) for relationship between explanatory variable and definition of dental utilization.

[c]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in exploratory sample.

[d]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in confirmatory sample.

[a]Overall F-statistic for retained explanatory variables (in rows immediately above) in the category predicting utilization. Degrees of freedom stated as: model, exploratory/confirmatory.

Table A.7

EXPLAINING ADULT USERS' TOTAL EXPENDITURES ON DENTAL CARE: RESULTS OF ANALYSES TO SELECT VARIABLES THAT BEST REPRESENT EXPLANATORY CATEGORIES

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Oral Health Status						
Clinically Assessed						
DMF28_D	.21	<.0001	+	3.89	+	3.01
DMF28_M	.20	<.0001	+	4.50	+	2.84
DMF28_F	-.02	NS	+	5.72	+	4.70
Periodontal Index	.19	<.0001	+	1.67	+	3.17
Oral health, year 2	.12	<.0001	+	2.03	+	0.91
$F_{5,567/496}$[e]			13.44	(p<.001)	9.14	(p<.001)
Oral Hygiene Index	.13	<.01	—	—	—	—
Common Survey Self-Report Measures						
Toothache	.19	<.0001	+	2.03	-	0.83
Bleeding gums	.05	NS	+	0.72	+	3.12
$F_{2,668/585}$			2.45	(p<.10)	4.95	(p<.01)
Other Self-Report Measures						
Need cleaning	.17	<.0001	+	2.31	+	1.46
Impact of disease	.31	<.0001	+	3.23	+	3.87
$F_{2,1005/927}$			9.79	(p<.001)	10.06	(p<.001)
General Health Perceptions						
Health Worry	.03	NS	+	2.65	+	2.27
Health Outlook	.00	NS	+	0.06	-	0.24
Resistance to Illness	.03	NS	+	0.36	-	0.41
$F_{3,1084/1012}$			2.65	(p<.10)	2.67	(p<.01)
Sickness Orientation	.00	NS	—	—	—	—
Current Health	-.05	NS	—	—	—	—
Prior Health	-.01	NS	—	—	—	—
Satisfaction with Dental Care						
General Satisfaction	-.06	<.01	-	1.22	-	2.78
Pain Management	.05	NS	-	2.34	-	2.12
Cost of Care	.03	NS	-	1.13	-	1.20
$F_{3,1081/999}$			3.30	(p<.05)	5.01	(p<.01)
Technical Quality	.17	<.0001	—	—	—	—

Table A.7—continued

Explanatory Category/Variable[a]	Bivariate[b] r	Bivariate[b] p	Multivariate: Exploratory[c] Sign	Multivariate: Exploratory[c] t	Multivariate: Confirmatory[d] Sign	Multivariate: Confirmatory[d] t
Access	.13	<.0001	—	—	—	—
Availability/Convenience	.06	NS	—	—	—	—
Health-Related Beliefs, Knowledge, and Other Attitudes						
Efficacy of Self-Care	.01	NS	+	1.17	−	1.12
Doctor's Mistakes	.01	NS	−	1.62	+	0.13
Efficacy of Doctor's Care	.00	NS	−	1.12	+	1.49
$F_{3,890/809}$			1.58	(p>.10)	1.62	(p>.10)
Belief in Role of Chance	.02	NS	—	—	—	—
Rejection of Patient Role	.08	<.05	—	—	—	—
Consumer Sophistication	.01	NS	—	—	—	—
Health Concern	−.03	NS	—	—	—	—
Attitude Toward Going to Doctor	.05	NS	—	—	—	—
Continuity of Care						
Continuity of Dental Care	−.05	<.05	−	1.85	−	1.54
$F_{1,1000/936}$			3.43	(p<.05)	2.38	(p<.10)
Sociodemographics						
Age	.11	<.0001	+	1.48	+	4.06
Gender (female)	−.03	NS	−	1.18	−	1.16
Ethnicity (black)	.08	<.01	+	2.16	+	0.46
Less than high school	.05	<.05	−	0.41	+	1.22
Some college	.01	NS		0.00	+	0.41
College graduate	−.08	<.001	−	2.57	−	1.52
Family income	−.06	NS	−	1.04	−	2.82
Missing income	.01	NS	−	0.10	+	0.54
Family size	.01	NS		0.73	+	1.50
Coinsurance 25%	−.03	NS	−	1.39	−	0.29
Coinsurance 50%	−.04	<.01	−	0.54	−	1.64
Coinsurance 95%	−.13	<.0001	−	0.36	−	1.58
Individual deductible	−.01	NS	−	0.30	−	2.10
Fitchburg	−.07	<.001	−	3.88	−	2.52
Franklin County	−.11	<.0001	−	4.84	−	3.29
Charleston	.03	NS	−	0.50	−	1.44
Georgetown County	−.01	NS	−	2.81	−	2.50
$F_{17,1060/1013}$			3.30	(p<.001)	3.50	(p<.001)

Table A.7—continued

Explanatory Category/Variable[a]	Bivariate[b]		Multivariate: Exploratory[c]		Multivariate: Confirmatory[d]	
	r	p	Sign	t	Sign	t
Employed	-.02	NS	—	—	—	—
Married	.03	NS	—	—	—	—
AFDC	.04	NS	—	—	—	—
Missing AFDC	.01	NS	—	—	—	—

NOTE: NS = not significant.

[a]Within each category, the rows listed above the test statistic row identify variables that were retained to define the category; those listed after the test statistic row were excluded.

[b]Simple correlation (r) and p-value (p) for relationship between explanatory variable and definition of dental utilization.

[c]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in exploratory sample.

[d]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in confirmatory sample.

[e]Overall F-statistic for retained explanatory variables (in rows immediately above) in the category predicting utilization. Degrees of freedom stated as: model, exploratory/confirmatory.

Table A.8

χ^2 FOR ADDING EXCLUDED VARIABLES TO BEST EXPLANATORY VARIABLES IN PREDICTING PROBABILITY OF USE, EXPLORATORY SAMPLE[a]

Explanatory Category	Degrees of Freedom	Any Use	Preventive	Illness-Related
Oral Health Status	1	1.00	2.27	0.08
General Health Perceptions	3	0.72	0.78	4.02
Satisfaction with Dental Care	2	1.77	4.52	0.54
Health-Related Beliefs	4	1.62	1.86	2.78
Sociodemographics	4	0.97	0.98	1.18

[a]p-values for all χ^2 statistics are $> .10$.

Table A.9

χ^2 FOR ADDING EXCLUDED VARIABLES TO BEST EXPLANATORY VARIABLES IN PREDICTING PROBABILITY OF USE, CONFIRMATORY SAMPLE

Explanatory Category	Degrees of Freedom	Any Use	Preventive	Illness-Related
Oral Health Status	1	5.42[a]	3.32[b]	0.14
General Health Perceptions	3	0.78	1.28	1.92
Satisfaction with Dental Care	2	0.92	3.40	3.14
Health-Related Beliefs	4	8.24[b]	5.42	4.82
Sociodemographics	4	3.24	4.88	0.94

[a]$p < .05$.
[b]$p < .10$; p-values for all other χ^2 statistics are $> .10$.

Table A.10

F-TEST FOR ADDING EXCLUDED VARIABLES TO BEST EXPLANATORY VARIABLES: IN PREDICTING EXPENDITURES FOR USERS, EXPLORATORY SAMPLE

Explanatory Category	Any Use		Preventive		Illness-Related	
	df[a]	F	df	F	df	F
Oral Health Status	1,566	0.94	1,515	0.14	1,413	0.00
General Health Perceptions	3,1080	2.28[b]	3,983	0.64	3,811	1.25
Satisfaction with Dental Care	3,1078	0.61	3,980	0.95	3,808	1.17
Health-Related Beliefs	4,886	0.14	4,809	0.73	4,661	0.46
Sociodemographics	4,1056	0.56	4,957	0.68	4,785	1.79

[a]df = degrees of freedom.
[b]$p < .10$; p-values for all other F-tests are $> .10$.

Table A.11

F-TEST FOR ADDING EXCLUDED VARIABLES TO BEST EXPLANATORY VARIABLES: IN PREDICTING EXPENDITURES FOR USERS, CONFIRMATORY SAMPLE

Explanatory Category	Any Use		Preventive		Illness-Related	
	df[a]	F	df	F	df	F
Oral Health Status	1,495	5.51[b]	1,447	2.13	1,367	0.25
General Health Perceptions	3,1012	2.67[b]	3,909	0.44	3,753	2.16
Satisfaction with Dental Care	3,996	5.46[c]	3,892	2.04	3,740	2.57
Health-Related Beliefs	4,805	1.27	4,729	1.24	4,597	2.32
Sociodemographics	4,1009	1.00	4,899	0.53	4,750	1.33

[a]df = degrees of freedom.
[b]$p < .05$.
[c]$p < .001$; p-values for all other F-tests are $> .10$.

Table A.12

χ^2-STATISTICS FOR DIFFERENCE BETWEEN COEFFICIENTS OF RETAINED VARIABLES, BY CATEGORY, IN EXPLORATORY AND CONFIRMATORY SAMPLES

	Probability				Expenditures			
Explanatory Category	df [a]	P	I	T [b]	df	P	I	T
Oral Health Status								
Clinically assessed	6	5.78	6.49	8.34	6	2.81	5.01	3.29
Common self-report	3	5.27	0.91	3.73	3	0.74	10.33	7.11
Other self-report	3	0.71	1.22	1.23	3	7.36	2.51	1.32
General Health Perceptions	4	1.50	1.65	3.01	4	0.22	1.47	0.74
Satisfaction with Dental Care	5	4.87	7.05	3.87	4	2.46	1.17	1.94
Health-Related Beliefs, Knowledge, and Attitudes	5	3.06	4.79	2.94	4	1.15	8.79	11.04
Continuity of Care	2	0.13	0.46	0.94	2	0.63	2.71	1.32
Sociodemographics	18	16.40	17.84	12.41	18	10.79	26.90	14.51

[a] Degrees of freedom for test, which included intercept and all retained variables in the category (see Table 3).

[b] P = preventive services.
I = illness-related services.
T = total services.

Table A.13

RESULTS FROM LOGIT REGRESSION: PROBABILITY OF ANY DENTAL USE BY ADULTS

Variable	Coefficient	Standard Deviation (Coeff)	t	Co-Linear
Intercept	−2.0339E-01	1.010E+00	−0.20	0.000
DMF28_D	5.8210E-02	2.882E-02	2.02	0.429
DMF28_M	−2.7715E-02	1.559E-02	−1.78	0.510
DMF28_F	3.4596E-02	1.443E-02	2.40	0.539
Periodontal Index	−3.0312E-01	1.647E-01	−1.84	0.473
Oral health, year 2	−6.2899E-01	2.222E-01	−2.83	0.356
Toothache	−1.4246E-01	1.379E-01	−1.03	0.241
Bleeding gums	−1.8180E-01	1.607E-01	−1.13	0.233
Need cleaning	−2.836OE-01	1.327E-01	−2.14	0.178
Impact of Disease	7.4597E-02	4.699E-02	1.59	0.384
Current Health	−7.5435E-03	5.050E-03	−1.49	0.575
Health Outlook	5.7838E-03	5.087E-03	1.14	0.490
Resistance to Illness	1.2661E-03	4.498E-03	0.28	0.409
Health Worry	1.7648E-03	3.662E-03	0.48	0.399
Availability/Convenience	−5.9852E-04	8.978E-03	−0.07	0.814
$Access^2$	1.6552E-05	3.734E-05	0.44	0.320
Pain Management	4.2386E-03	1.174E-02	0.36	0.945
Availability × Pain	−1.3388E-05	1.715E-04	−0.08	0.962
Cost of Care	−2.6102E-03	3.644E-03	−0.72	0.283
General Satisfaction	−7.2713E-04	2.796E-03	−0.26	0.133
Efficacy of Self-Care	−1.1922E-02	3.827E-03	−3.12	0.202
Efficacy of Doctor's Care	−1.2293E-02	4.951E-03	−2.48	0.203
Doctor's Mistakes	−1.9564E-03	3.368E-03	−0.58	0.261
Attitude Toward Going to Doctor	1.0791E-03	2.218E-03	0.49	0.207
Continuity	3.1551E-01	1.019E-01	3.10	0.289
Age	1.4808E-02	6.522E-03	2.27	0.467
Gender (female)	3.8560E-01	1.209E-01	3.19	0.181
Ethnicity (black)	−1.8959E-01	2.609E-01	−0.73	0.358
Family size	9.2588E-03	4.463E-02	0.21	0.233
Family income	4.9764E-05	1.166E-05	4.27	0.250
Missing income	−8.2617E-02	2.728E-01	−0.30	0.105
Less than high school	2.4354E-01	1.738E-01	1.40	0.336
Some college	2.0513E-01	1.916E-01	1.07	0.179
College graduate	4.6023E-01	1.959E-01	2.35	0.227
Site	2.6555E-01	1.030E-01	2.58	0.336
Coinsurance	−8.0898E-02	1.564E-02	−5.17	0.135

Table A.14

RESULTS FROM ORDINARY LEAST SQUARES REGRESSION: LOG (ANNUAL DENTAL EXPENDITURES, IF ANY), ADULTS

Variable	Coefficient	Standard Deviation (Coeff)	t	Co-Linear
Intercept	2.5771E+00	7.569E-01	3.41	0.000
DMF28_D	7.6030E-02	2.065E-02	3.68	0.497
DMF28_M	5.7544E-02	1.254E-02	4.59	0.564
DMF28_F	6.7189E-02	8.984E-03	7.48	0.622
Periodontal Index	2.6234E-01	1.316E-01	1.99	0.459
Oral health, year 2	3.5568E-01	2.343E-01	1.52	0.467
Toothache	−7.4262E-02	9.381E-02	−0.79	0.345
Bleeding gums	1.2342E-01	1.295E-01	0.95	0.268
Need cleaning	1.3040E-01	8.382E-02	1.56	0.259
Impact of disease	4.0508E-02	3.617E-02	1.12	0.406
Current Health	−7.5400E-04	3.198E-03	−0.24	0.642
Health Outlook	4.0198E-03	3.099E-03	1.30	0.567
Resistance to Illness	−3.9809E-03	2.933E-03	−1.36	0.421
Health Worry	1.8191E-03	2.505E-03	0.73	0.420
Availability/Convenience	5.2121E-03	6.828E-03	0.76	0.829
Access^2	4.3332E-05	2.445E-05	1.77	0.417
Pain Management	6.9990E-03	8.206E-03	0.85	0.956
Availability × Pain	−1.4124E-04	1.186E-04	−1.19	0.968
Cost of Care	−3.3473E-03	2.541E-03	−1.32	0.223
General Satisfaction	−20914E-03	1.893E-03	−1.10	0.187
Efficacy of Self-Care	−2.2398E-03	2.745E-03	−0.82	0.242
Efficacy of Doctor's Care	2.0041E-03	3.173E-03	0.63	0.254
Doctor's Mistakes	1.8397E-03	2.224E-03	0.83	0.230
Attitude Toward Going to Doctor	1.1683E-04	1.503E-03	0.08	0.245
Continuity	−3.5570E-02	7.727E-02	−0.46	0.300
Age	−7.4094E-03	4.308E-03	−1.72	0.431
Gender (female)	−1.5989E-01	8.384E-02	−1.91	0.183
Ethnicity (black)	3.7034E-01	2.182E-01	1.70	0.486
Family size	−5.2488E-03	2.854E-02	−0.18	0.246
Family income	4.6787E-06	6.419E-06	0.73	0.291
Missing income	−1.1685E-01	2.525E-01	−0.46	0.177
Less than high school	−4.2214E-02	1.336E-01	−0.32	0.399
Some college	3.3779E-02	1.172E-01	0.29	0.329
College graduate	−1.3265E-01	1.267E-01	−1.05	0.383
Site	−2.1359E-02	7.455E-02	−0.29	0.422
Coinsurance	−3.1010E-02	1.036E-02	−2.99	0.174

Table A.15

DESCRIPTIVE STATISTICS FOR EXPLANATORY AND DEPENDENT VARIABLES, CHILDREN'S UTILIZATION ANALYSES

Category/Variable	N	Mean	Standard Error	Possible Scores	Observed Scores
Oral Health Status					
DMF28_D	586	1.49	0.09	0–28	0–13
DMF28_M	586	0.21	0.03	0–28	0–4
DMF28_F	586	1.30	0.08	0–28	0–14
Oral Hygiene Index	756	1.37	0.02	0–6	0–4.5
Dental Pain	1070	1.22	0.02	1–4	1–4
Bleeding Gums	826	0.14	0.01	0,1	0,1
Wears Braces	1073	0.04	0.01	0,1	0,1
Parent's Perceptions of Child's General Health					
Current Health	1146	85.57	0.46	0–100	9.1–100
Prior Health	1144	78.09	0.85	0–100	0–100
Resistance to Illness	1144	74.25	0.58	0–100	0–100
EGFP	1144	3.56	0.02	1–4	1–4
Parent's Satisfaction with Dental Care					
Availability/Convenience	1227	65.51	0.50	0–100	0–100
Accessibility	1230	57.75	0.52	0–100	0–100
Cost	1229	39.11	0.55	0–100	0–100
Technical Quality	1230	64.54	0.33	0–100	28.6–100
Pain Management	1230	50.29	0.61	0–100	0–100
General Satisfaction	1227	59.82	0.69	0–100	0–100
Parent's Health-Related Knowledge					
Consumer Sophistication	978	64.27	0.66	0–100	0–100
Parent's Health-Related Beliefs and Attitudes					
Efficacy of Self-care	1234	42.52	0.48	0–100	0–100
Efficacy of Doctor's Care	1234	63.22	0.39	0–100	0–100
Attitude Toward Going to Doctor	1246	47.72	0.83	0–100	0–100
Doctor's Mistakes	1233	60.44	0.55	0–100	0–100
Rejection of Patient Role	1246	72.85	0.43	0–100	0–100
Belief in Role of Chance	1231	47.95	0.68	0–100	0–100
Parent's Health-Related Worry and Concern					
Health concern	1244	51.43	0.63	0–100	0–100
Sickness orientation	1246	57.24	0.71	0–100	0–100
Health worry	1144	3.45	0.02	1–4	1–4

Table A.15—continued

Category/Variable	N	Mean	Standard Error	Possible Scores	Observed Scores
Continuity of Dental Care					
Continuity	1143	2.08	0.02	0–3	0–3
Sociodemographics					
Age	1311	8.96	0.08	4–14	4–13.99
Gender (female)	1311	0.50	0.01	0,1	0,1
Ethnicity (black)	1311	0.20	0.01	0,1	0,1
Family size	1311	5.06	0.05	—	1–14
Birth order	1285	2.15	0.03	—	1–8
Family income	1311	13703.20	186.13	—	1–49990
Missing family income	1311	0.09	0.01	0,1	0,1
Employed	1297	0.39	0.01	0,1	0,1
Married	1307	0.80	0.01	0,1	0,1
AFDC	1311	0.11	0.01	0,1	0,1
Missing AFDC	1311	0.03	0.004	0,1	0,1
Education	1311	11.84	0.07	—	0–18
Less than high school		0.29	0.01	0,1	0,1
High school graduate		0.45	0.01	0,1	0,1
Some college		0.16	0.01	0,1	0,1
College graduate		0.10	0.01	0,1	0,1
Site	1311				
Seattle		0.36	0.01	0,1	0,1
Fitchburg		0.13	0.01	0,1	0,1
Franklin County		0.17	0.01	0,1	0,1
Charleston		0.14	0.01	0,1	0,1
Georgetown County		0.20	0.01	0,1	0,1
Insurance Plan	1311				
Free (0% coinsurance)		0.47	0.01	0,1	0,1
Coinsurance 25%		0.06	0.01	0,1	0,1
Coinsurance 50%		0.14	0.01	0,1	0,1
Coinsurance 95%		0.14	0.01	0,1	0,1
Individual deductible		0.19	0.01	0,1	0,1
Dental Utilization					
Probability of use	1311	0.66	0.01	0,1	0,1
Expenditures (log $)	864	3.41	0.03	—	0.92–7.5

In Tables A.16 and A.17, the first pair of columns presents results from bivariate analyses of relationships between each of the explanatory variables we considered and one of the definitions of dental utilization. The second pair of columns summarizes results from the build-up and build-down analyses. Within each explanatory category, the variables that best represented the category are listed first, followed by the χ^2-statistic for the subset. Column entries for these variables indicate the sign and t-statistic for the partial correlation in the final regression. The variables that were excluded from the definition of each explanatory category are listed second.

Table A.16

EXPLAINING PROBABILITY OF CHILDREN'S USE OF DENTAL CARE: RESULTS OF ANALYSES TO SELECT VARIABLES THAT BEST REPRESENT EACH EXPLANATORY CATEGORY

Explanatory Category/Variable	Bivariate[a] r	Bivariate[a] p	Multivariate[b] Sign	Multivariate[b] t
Oral Health Status				
DMF28_D	−.20	<.0001	−	1.78
Oral Hygiene Index	−.26	<.0001	−	1.46
Bleeding gums	−.15	<.0001	−	2.36
χ^{2c}_3			18.0	(p<.0001)
DMF28_M	−.04	NS		—
DMF28_F	.07	NS		—
Wears braces	.03	NS		—
Dental pain	−.04	NS		—
Parent's Perceptions of Child's General Health[d]				
Current Health	.12	<.0001	+	1.35
EGFP	.12	<.0001	+	1.02
Resistance to Illness	.01	NS	−	1.65
χ^2_3			13.7	(p<.01)
Prior Health	.00	NS		—
Parent's Satisfaction with Dental Care[d]				
Pain Management	.12	<.0001	+	2.32
Availability/Convenience	.20	<.0001	+	4.64
General Satisfaction	.11	<.001	+	2.89
Cost of Care	.01	NS	−	1.13
χ^2_4			34.9	(p<.0001)
Access	.11	<.0001		—
Technical Quality	.11	<.0001		—
Parent's Health-Related Knowledge[d]				
Consumer Sophistication	.10	<.01	+	2.20
χ^2_1			4.8	(p<.05)
Parent's Health-Related Beliefs and Attitudes[d]				
Efficacy of Self-Care	.07	<.01	−	1.28
Belief in Role of Chance	−.05	NS	−	0.79
Attitude Toward Going to Doctor	.05	NS	+	1.21
χ^2_3			4.7	(p>.10)
Doctor's Mistakes	.01	NS		—
Efficacy of Doctor's Care	.01	NS		—

Table A.16—continued

Explanatory Category/Variable	Bivariate[a] r	Bivariate[a] p	Multivariate[b] Sign	Multivariate[b] t
Parent's Health-Related Worry and Concern				
Health Concern	−.07	<.01	−	1.74
χ^2_1			3.0	(p<.10)
Health Worry	−.02	NS		—
Sickness Orientation[d]	−.04	NS		—
Continuity of Dental Care				
Continuity	.28	<.0001	+	7.38
χ^2_1			54.5	(p<.0001)
Sociodemographics				
Age	−.03	NS		
Ethnicity (black)	−.28	<.0001	−	2.35
Family size	−.13	<.0001	−	1.86
Family income	.21	<.0001	+	1.55
Missing income	−.14	<.0001	−	1.97
Number of family heads	.17	<.0001	+	2.56
Gender (female)	.00	NS	+	0.93
Employed[d]	−.04	NS	−	1.34
Less than high school[d]	−.21	<.0001	−	2.77
Some college[d]	.00	NS	−	1.55
College graduate[d]	.14	<.0001	+	2.27
Site	−.20	<.0001	+	0.16
Fitchburg	−.03	NS		—
Franklin County	.20	<.0001		—
Charleston	−.19	<.0001		—
Georgetown County	−.16	<.0001		—
Coinsurance 25%	−.05		−	2.79
Coinsurance 50%	−.10	<.001	−	4.20
Coinsurance 95%	−.08	<.01	−	3.26
Individual deductible	−.12	<.0001	−	4.94
χ^2_{16}			115.1	(p<.0001)
Birth order (first)	−.09	<.001		—
AFDC	−.11	<.0001		—
Missing AFDC	−.01			—
Married[d]	.15	<.0001		—

NOTE: NS = not significant.

[a]Simple correlation (r) and p-value (p) for relationship between explanatory variable and definition of dental utilization. Sample sizes for the correlations between use and clinical assessments of oral health ranged from 586 to 826; samples ranged from 998 to 1311 for all other bivariate analyses.

[b]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in exploratory sample.

[c]Overall χ^2-statistic for retained explanatory variables (in rows immediately above) in the category predicting utilization.

[d]Scores on these variables came from the family's medical care decisionmaker, usually the female head.

Table A.17

EXPLAINING CHILDREN'S DENTAL EXPENDITURES: RESULTS OF ANALYSES TO SELECT VARIABLES THAT BEST REPRESENT EXPLANATORY CATEGORIES

Explanatory Category/Variable	Bivariate[a]		Multivariate[b]	
	r	p	Sign	t
Oral Health Status				
DMF28_D	.23	<.0001	+	3.33
Oral Hygiene Index	.20	<.0001	+	0.55
DMF28_F	.04	NS	+	0.31
χ^{2c}_3			15.4	(p<.01)
DMF28_M	.02	NS		—
Bleeding gums	.07	NS		—
Wears braces	−.01	NS		—
Dental pain	.03	NS		—
Parent's Perceptions of Child's General Health[d]				
Resistance to Illness	.07	<.05	+	3.13
EGFP	−.08	<.05	−	0.95
Current Health	−.06	NS	−	1.24
χ^2_3			12.7	(p<.01)
Prior Health	−.04	NS		—
Parent's Satisfaction with Dental Care[d,e]				
Availability/Convenience	.01	NS		—
Access	−.03	NS		—
Cost of Care	−.04	NS		—
Pain Management	−.06	NS		—
Technical Quality	−.05	NS		—
General Satisfaction	.01	NS		—
Parent's Health-Related Knowledge[d]				
Consumer Sophistication	.07	NS	+	1.55
χ^2_1			4.8	(p>.10)
Parent's Health-Related Beliefs and Attitudes[d]				
Doctor's Mistakes	.06	NS	+	1.50
Efficacy of Doctor's Care	.03	NS	+	1.15
χ^2_2			2.4	(p<.10)
Belief in Role of Chance	.04	NS		—
Attitude Toward Going to Doctor	.00	NS		—
Efficacy of Self-Care	.02	NS		—

Table A.17—continued

Explanatory Category/Variable	Bivariate[a] r	Bivariate[a] p	Multivariate[b] Sign	Multivariate[b] t
Parent's Health-Related Worry and Concern				
Health Worry	−.10	<.01	−	2.37
Health Concern	−.04	NS	−	1.20
χ^2_2			7.0	(p<.05)
Sickness Orientation[a]	.06	NS		—
Continuity of Dental Care[d]				
Continuity	−.09	<.01	−	2.00
χ^2_1			4.0	(p<.05)
Sociodemographics				
Age	.10	<.01	+	0.21
Gender (female)	.00	NS	−	0.16
Ethnicity (black)	.16	<.0001	+	4.32
Family income	−.04	NS	+	0.41
Missing income	−.06	NS	−	2.10
Employed[a]	.08	<.01	+	1.93
Married[a]	−.12	<.001	−	1.44
Less than high school[a]	.10	<.01	+	1.96
Some college[a]	.01	NS	+	0.77
College graduate[a]	−.08	<.01	−	1.32
Site	−.09	<.01	−	5.02
Fitchburg	−.05	NS		—
Franklin County	−.13	<.0001		—
Charleston	.03	NS		—
Georgetown County	−.02	NS		—
Coinsurance 25%	−.04	NS	−	1.38
Coinsurance 50%	−.05	NS	−	1.05
Coinsurance 95%	−.01	NS	−	1.01
Individual deductible	−.09	<.01	−	1.78
χ^2_{15}			86.4	(p<.0001)

Table A.17—continued

Explanatory Category/Variable	Bivariate[a]		Multivariate[b]	
	r	p	Sign	t
Family size	.11	<.001	—	
Birth order (first)	.09	<.01	—	
AFDC	.04	NS	—	
AFDC missing	−.06	NS	—	
Number of family heads	−.08	<.05	—	

NS = not significant.

[a]Simple correlation (r) and p-value (p) for relationship between explanatory variable and definition of dental utilization. Sample sizes for the correlations between use and clinical assessments of oral health ranged from 586 to 826; samples ranged from 998 to 1311 for all other bivariate analyses.

[b]Direction (sign) and t-statistic (t) for coefficient on explanatory variable in multivariate analysis of retained variables in the category predicting utilization in exploratory sample.

[c]Overall χ^2-statistic for retained explanatory variables (in rows immediately above) in the category predicting utilization.

[d]Scores on these variables came from the family's medical care decisionmaker, usually the female head.

[e]A multivariate model of dental satisfaction was not tested (see text).

Table A.18

χ^2 FOR ADDING EXCLUDED VARIABLES TO BEST EXPLANATORY VARIABLES: PREDICTING CHILDREN'S USE[a]

Explanatory Category	Probability		Expenditures	
	df[b]	χ^2	df	χ^2
Oral Health Status	4	4.7	4	1.5
Parent's Perceptions of Child's General Health	1	0.4	1	1.2
Parent's Satisfaction with Dental Care	2	1.5	—	—
Parent's Health-Related Beliefs and Attitudes	2	1.0	3	0.8
Parent's Health-Related Worry and Concern	2	0.9	1	0.9
Sociodemographics	4	2.3	5	6.8

NOTE: df = degrees of freedom.
[a]p-values for all χ^2 statistics are > .10.

Table A.19

NEGATIVE BINOMIAL REGRESSION RESULTS: PREDICTING SECOND QUARTER DENTAL VISIT COUNTS

Explanatory Category	Coefficient	Standard Deviation (Coeff)	t	Co-linear
Intercept	5.4492E-01	3.083E-01	1.77	0.00
General Health	1.0493E-04	1.069E-04	0.98	0.04
Dental Satisfaction	5.1210E-03	3.200E-03	1.60	0.16
Health Beliefs	2.8577E-04	2.993E-03	0.10	0.12
Attitude Toward Going to Doctor	5.0730E-04	1.225E-03	0.41	0.07
Continuity	3.0330E-03	2.037E-03	1.49	0.12
Income	5.5046E-06	4.983E-06	1.10	0.03

Table A.20

NEGATIVE BINOMIAL REGRESSION RESULTS: PREDICTING THIRD QUARTER DENTAL VISIT COUNTS

Explanatory Category	Coefficient	Standard Deviation (Coeff)	t	Co-linear
Intercept	1.0817E+00	3.106E-01	3.48	0.00
General Health	−1.0183E-04	1.015E-04	−1.00	0.06
Dental Satisfaction	1.1385E-03	3.127E-03	0.36	0.149
Health Beliefs	−4.6067E-03	3.340E-03	−1.38	0.10
Attitude Toward Going to Doctor	−1.9995E-03	1.255E-03	−1.59	0.11
Continuity	4.1621E-03	2.016E-03	2.06	0.12
Income	2.0365E-05	4.795E-06	4.25	0.03

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