A Method for Assessing Dental Manpower Need Is Tested in a Low Income Area of Philadelphia

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DENTAL MANPOWER NEEDS have been most commonly evaluated by means of a determination of the dentist-to-population ratio in a given geographic area and a comparison of that ratio to the national average of about 1 dentist for 2,000 people *(1–4)*. Areas with a ratio of less than 1 : 2,000 are considered to be underserved by dental manpower, whereas those with more than 1 : 2,000 are considered to have an excess of dentists. This simple approach is based on the following assumptions: *(a)* a ratio of 1 : 2,000 is universally optimal, *(b)* the productivity of all dentists is relatively equal, and *(c)* the demands of all population segments are relatively equal.

According to several recent reports, however, the preceding assumptions are incorrect *(5–10)*. These reports indicate that many factors (age, sex, race, occupation, income, education, and others) affect dental demand and that other variables (age, auxiliary personnel, and number of hours worked) affect dentists' productivity.

Because the variables—at least the most pertinent ones—generally were not included in previous evaluations and because one of us (R.D.M.) had been asked by the Philadelphia County Dental Society to evaluate the need for more dentists in areas of the city where National Health Service Corps dentists might be requested, a new methodology for such assessment was developed *(11)*. We tested this method in a low-income area of north central Philadelphia.

Mr. Rosenbaum and Mr. Speicher, dental students at Temple University School of Dentistry, were employed at the time of this study in the Department of Community Dentistry with the support of a traineeship grant, No. 5A07-AH00244-04, from the Division of Dental Health, Bureau of Health Manpower Education, Department of Health, Education, and Welfare. Dr. Tannenbaum, special assistant for health affairs to the Insurance Commissioner of Pennsylvania, was a graduate student at the University of Michigan School of Public Health at the time of this study. Dr. Mumma is professor and chairman, Department of Community Dentistry.

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Methodology

Recognizing that an excessive number of variables would be difficult to deal with, that hard data were available only for some variables, and that the implications of some variables were redundant, we selected the three most pertinent indicators of dental demand and the one most pertinent indicator of practitioner busyness: *(a)* for the population—age, family income, and race and *(b)* for the dentist—number of patient visits per year.

Only three population characteristics were selected for this study because they are easy to apply and therefore more likely to be used. Other characteristics, also relevant and available from existing data—such as occupation and education levels—were excluded, because we believed that the three variables selected would be the most indicative and that data on these three would be the most objective without introducing excessive repetition or subjectivity. Moreover, use of the three variables could yield a common denominator of measurability; that is, given a certain area, its residents, and its dentists we could determine from demographic data the expected utilization or demand in terms of anticipated patient visits per year. We arbitrarily gave equal weight to each factor—age, race, and family income—in calculating demand, primarily because of a lack of evidence for an alternative to that approach.

Thus, anticipated demand could be compared with the actual busyness of dentists in the study area, as determined by numbers of patient visits per year. If the anticipated demand were to exceed dentists' busyness, additional manpower would be needed. If the two factors were equal or the demand less than the busyness

(or potential busyness as determined by the dentist's ability to accept more patients), no increase in manpower would be recommended. The use of the dental visit as a basic unit for measuring dentists' productivity has been employed previously *(12)*.

We selected the census tract as the basic geographic unit for the study because *(a)* the census tract has definite boundaries, *(b)* data on race, socioeconomic status, and age are readily obtainable for each census tract, and *(c)* generally, the people in a census tract have similar lifestyles, race, age composition, and income. For necessary demographic data, we used the 1970 Census of Population and Housing (Philadelphia), published by the U.S. Census Bureau *(13)*. To locate dentists practicing in the study area, we cross-referenced the names obtained from the local dental society with those listed in the telephone directory.

As part of the study plan, if no information could be obtained from a practicing dentist—for whatever reason—the mean number of patient visits per year for dentists practicing in the study area would be assigned to that dentist. For nonresponding dentists who were older than 65 years, however, one-half of the mean value would be assigned on the assumption that their productivity would be lower than that of the younger dentists. In situations in which insufficient information was available for a reliable mean figure (perhaps because there was no other practitioner in the area), the value of 3,015 patient visits—the national average of patient visits to a dentist with one assistant *(9)*—would be used for a nonresponding dentist. Regardless of the approach used, however, the investigators agreed to use a method for determining dentist productivity that was most suitable for the study area.

Anticipated use. The method for assessing dental manpower needs was carried out as follows:

1. An area of questionable need was identified by census tracts, city limits, county, Standard Metropolitan Statistical Area, or other.
2. The age, income, and racial characteristics of that area were entered in the calculation of the formula

$$x = (x_1 + x_2 + x_3)/3$$

where x represented the average utilization expected in terms of dental visits per year based on age (x_1), family income (x_2), and race (x_3).

The influence of the age distribution of the population concerned (x_1) was then calculated as

$$x_1 = a_{11}\,x_{11} + a_{12}\,x_{12} + a_{13}\,x_{13} + a_{14}\,x_{14} + a_{15}\,x_{15}$$

where

a_{11} = 1.3 dental visits per person per year, ages 3–13
a_{12} = 2.2 dental visits per person per year, ages 14–24
a_{13} = 1.6 dental visits per person per year, ages 25–44
a_{14} = 1.3 dental visits per person per year, ages 45–64
a_{15} = 0.8 dental visit per person per year, ages 65 and over *(2)*

and

x_{11} = number of people in area, ages 3–13
x_{12} = number of people in area, ages 14–24
x_{13} = number of people in area, ages 25–44
x_{14} = number of people in area, ages 45–64
x_{15} = number of people in area, ages 65 and over

Thus, x_1 represented the total number of dental visits expected in the target area in a year based on the ages of its residents.

The influence of the family incomes of the population was then calculated as follows (each income category was adjusted upward by $2,500 to accommodate the effect of inflation from 1964 to 1974):

$$x_2 = a_{21}\,x_{21} + a_{22}\,x_{22} + a_{23}\,x_{23} + a_{24}\,x_{24} + a_{25}\,x_{25}$$

where

a_{21} = 0.9 dental visit per person per year, income < $7,500
a_{22} = 1.4 dental visits per person per year, income $7,500–$9,999
a_{23} = 1.7 dental visits per person per year, income $10,000–$12,499
a_{24} = 2.0 dental visits per person per year, income $12,500–$14,999
a_{25} = 2.8 dental visits per person per year, income $15,000 and over *(2)*

and

x_{21} = number of people in area, income < $7,500
x_{22} = number of people in area, income $7,500–$9,999
x_{23} = number of people in area, income $10,000–$12,499
x_{24} = number of people in area, income $12,500–$14,999
x_{25} = number of people in area, income $15,000 and over

Thus, x_2 represented the total number of dental visits per year expected in the target area based on the family income of its residents.

The influence of the racial distribution of the population concerned (x_3) was then calculated as follows:

$$x_3 = a_{31}\,x_{31} + a_{32}\,x_{32}$$

where

a_{31} = 1.6 dental visits per person per year for whites
a_{32} = 0.7 dental visit per person per year for nonwhites *(2)*

and

x_{31} = number of whites in area
x_{32} = number of nonwhites in area

Thus, x_3 represented the total number of dental patient visits expected in the study area based on racial distribution.

We found that an adjustment was necessary for treatment of data associated with inmates of institutions (inmates, as defined by the Census Bureau *(13)*), because some census tracts in the study area contained no institutionalized persons and others had large numbers of them. When the number of institutions and the type and number of inmates in a census tract were known,

we subtracted these persons from the appropriate demographic categories before calculating the demand. Of course, this adjustment assumes that the inmates do not contribute to the dental demand as met by private practitioners in the area. In census tracts having few institutionalized persons, these persons were included in the calculations because the difference was insignificant. Therefore, by using the preceding formulas and making the necessary adjustments, we could determine the expected actual utilization of dental visits in the target area.

Available dental resources. A letter was sent to all 16 identified dentists in the area which explained the nature of the study and told them that they would soon be telephoned and asked the following questions:

How many private patients per week are you now seeing? (We anticipated that from the answers to this question we could extrapolate a figure on total patient visits per year, because the usual pattern is no more than one visit per week for each patient.)

How many public assistance patients per week are you now seeing?

How many more private and public assistance patients per week could you see? (0–5, 6–10, 11–20, 21–30, more than 31)

Unmet demand. When the preceding telephone survey was completed, the dental manpower needs of the study area were assessed. The total number of patient visits as reported by the dentists was subtracted from the total number of visits expected based on the population's demographic composition, and thus we obtained the potential demand for care that was not being met by existing dental manpower in the study area.

National figures (*9*) show that the average dentist receives a mean of 2,355 to 6,170 patient visits per year, depending on the number of auxiliary personnel employed. The productivity of dentists, according to the number of full-time auxiliaries reported by the American Dental Association Survey of Dental Practice in 1965, is as follows:

Number of auxiliary personnel	*Mean number of patient visits per year*
0	2,355
1	3,015
2	3,946
3	4,409
4 or more	6,170

To determine the extent of the need in terms of the number of additional dentists that the study area could use, we divided the number of unmet dental visits per person per year by the appropriate number of dental visits per person per year that one dentist could manage. If, for example, 600 patient visits per year were not being met by dentists in a given area, the shortage would not be great enough to require the services of another full-time dentist. On the other hand, if the figure was 6,000, two additional full-time dentists with one auxiliary each could be used in the area.

Results

The total population of the study area, according to the 1970 census, was 66,764—47,611 nonwhite and 19,153 white. After adjustments were made for institutionalized persons by the method previouslv discussed, the figures came to 47,533 nonwhite and 19,075 white.

The age distribution of the people in the area, adjusted for the institutionalized population, was as follows:

	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}
Age:	3–13	14–24	25–44	45–64	65 and over
Number of people:	15,414	12,084	13,706	14,161	7,454

The expected dental utilization based on age was then calculated:

$$a_{11}\,x_{11} + a_{12}\,x_{12} + a_{13}\,x_{13} + a_{14}\,x_{14} + a_{15}\,x_{15} = x_1$$
$$1.3\ (15{,}414) + 2.2\ (12{,}084) + 1.6\ (13{,}706) + 1.3\ (14{,}161) + 0.8\ (7{,}454) = 92{,}924$$

It was thus anticipated that, based on age distribution, there would be a total of 92,924 dental visits per year (x_1) in the study area.

The income distribution in this section of the city was as follows:

	x_{21}	x_{22}	x_{23}	x_{24}	x_{25}
Income:	less than $7,500	$7,500–$9,999	$10,000–$12,499	$12,500–$14,999	$15,000 or more
Number of people:	37,014	21,991	7,602	0	0

The expected dentist utilization based on income was then calculated:

$$a_{21}\,x_{21} + a_{22}\,x_{22} + a_{23}\,x_{23} + a_{24}\,x_{24} + a_{25}\,x_{25} = x_2$$
$$0.9\ (37{,}014) + 1.4\ (21{,}991) + 1.7\ (7{,}602) + 2.0\ (0) + 2.8\ (0) = 77{,}023$$

Thus, based on income distribution, it was anticipated that there would be a total of 77,023 dental visits per year (x_2).

With the information on whites (19,075) and nonwhites (47,533) in the population, the expected dentist utilization based on race was then calculated:

$$a_{31}\,x_{31} + a_{32}\,x_{32} = x_3$$
$$1.6\ (19{,}075) + 0.7\ (47{,}533) = 63{,}793$$

Thus, it was anticipated that, based on racial composition, there would be a total of 63,793 dental visits per year (x_3).

Available dental resources. Of the 16 dentists with offices in the study area, 15 responded to the telephone survey, a response rate of 93.75 percent. The nonrespondent was 79 years old. The dentists reported a total of 727 patient visits (non-clinic) per week. Assuming that the dentists worked an average of 48 weeks per year, we multiplied 727 by 48, which resulted in 34,896 visits per year. The mean number of patient visits for the responding dentists was 48.5 per week or 2,326 per year. The mean value of 2,326 patient visits per year was also assigned to the nonrespondent rather than the halved mean value described previously, because the mean age of the study dentists approached 65, and the decreased patient load was reflected already in the statistics of the

study area. Thus, the total number of patient visits came to 37,222 per year (34,896+ 2,326). In an area with younger dentists, the halved mean may be more accurate for estimating the productivity of dentists older than 65 years.

Dental care is also provided in the study area by the District Health Center of the Philadelphia Department of Public Health, located at the outer boundary of the area. The center reported 6,832 dental visits for fiscal year 1970 (during fiscal year 1971, the clinic was closed for 6 months for refurbishing). Thus, the total number of patient visits per year for the study area was 44,054 (37,222 + 6,832).

In response to the question concerning how many more patients the dentists could see a week, 1 dentist said 180 because he was expanding his facilities. This dentist accounted for the major portion of the net increase for all 15 respondents—237.5 per week or 11,400 a year. Some respondents planned to decrease their patient load because of their age and also because of the high crime rate in the area; however, they could not provide reliable estimates of their anticipated decreases. With the additional 11,400 patient visits, therefore, the dental profession in the study area potentially could accommodate 55,454 patient visits a year.

Unmet demand. The unmet demand for the study area was determined as follows: total anticipated demand (previously calculated) 77,913 − 55,454 potential patient visits = 22,459 patient visits a year. Approximately seven additional dentists would be needed to meet this demand (22,459 ÷ 3,015, the mean number of patient visits anticipated for a dentist with one assistant).

To determine the extent to which the lowest income segment of the population in the study area was obtaining dental services, we compared the percentage of the population receiving public assistance with the percentage of the total dental care being provided (in terms of dental visits per year) which they received. According to the Census Bureau report (*13*), 21 percent of the people in the study area were on public assistance. According to the dentists surveyed, these people were receiving 15 percent of the dental care provided in the area.

Discussion

Any method that is developed to assess dental manpower need in a given geographic area must be imperfect because of human factors. It is not possible to predict accurately the extent to which a given population will use dental services. However, experience and previous studies have been sufficient to permit the development of a more accurate method of predicting such use than the usual approach, as results of this study show.

The study results indicate that seven more dentists will be needed in the study area, based on anticipated demand. On the other hand, if the dentist-to-population ratio were used—1 : 2,000 as the desirable criterion—nearly 2½ times as many dentists would be needed. Based on the figures of 16 dentists and 66,764 people in the study area, approximately 33 dentists would be required to approach the goal of 1 : 2,000. The following calculation supports this statement:

$$x : 66{,}764 = 1{:}2{,}000$$
$$x = 33 \text{ dentists}$$
$$33 - 16 = 17 \text{ additional dentists}$$

The obvious question, then, pertains to the relative merits of the two conclusions. Are 7 or 17 additional dentists needed, or is neither estimate valid? The only way to answer this question is to provide the indicated manpower and to observe the outcome; however, the shortage of manpower for such assignments makes such a solution unlikely. Therefore, the most productive approach toward a solution is to determine which of the two estimates is more likely to be correct and to use the method which shows greater promise.

Because of the apparent nongrowth situation in our low income study area, in which the mean age of the relatively few dentists was 62.5 years, the estimate of a need for 7 rather than 17 more dentists seems valid. Moreover, the method used in this study addresses the concerns of those who must assign personnel (who are concerned about assigning dentists to areas of greatest need) and the dental profession (who may be concerned about certifying shortage areas when they may be working against the interests of their members practicing in those areas).

In interpreting the results of our study, one should also consider several other factors that are particularly common in urban areas: *(a)* the mobility of the area's people, *(b)* the occurrence of population shifts, *(c)* the effect of dental specialists in the area on the dental manpower situation, *(d)* the extent to which public assistance recipients can obtain dental services, and *(e)* determination of the dental care goal in the area in relation to areas that do not appear to be underserved.

The factor of mobility of people in an area is related to the availability of care from dentists who practice outside the area. A basic assumption in our study is that the flow of patients out of a given area will be offset by the influx of patients into the area; although this situation may rarely hold, it is hoped that the differences will be negligible. In large urban areas, however, especially where there are public facilities and medical arts buildings, mobility differences may be quite large.

To overcome mobility differences, an area larger than the one being studied should be surveyed to see whether existing facilities in contiguous areas may be serving people who live in the target area. In such a situation, the predicted demand may be somewhat inflated because of the larger number of people being surveyed; but if this expansion of the area being studied reveals sufficient dental manpower to meet the needs of the people, an error in judgment caused by a narrower survey could be avoided. Of course, the wider survey would not apply to a person who travels to a noncon-

tiguous location for dental care. According to those who have worked with and observed the health behavior of low income groups, however, the likelihood of their seeking dental care, let along traveling any distance to obtain it, is substantially less than that of higher socioeconomic groups *(14)*. We can thus assume that the people in the study area depend on local providers for their dental care.

A factor in the mobility of people is whether significant changes occur in the size and makeup of the population in the area being studied; for example, an urban renewal project in some sections of north central Philadelphia has razed many housing units and thus predictions for dental manpower need in these sections must be made cautiously. In our study area, of course, the offsetting factor was the high average age of the practitioners rather than population mobility.

Unlike more affluent sections of the city, there were no dental specialists in the area we studied. If specialists had been present, however, we would have carefully examined their contribution to the supply of dental services because *(a)* they would draw patients from a far larger geographic base than that of the general dentists and *(b)* consideration should be given to the kinds of specialties represented. Specialties most likely to contribute significantly to the area's needs are children's dentistry, oral surgery, and prosthetic dentistry.

Concerning the public assistance recipients in our study area, it is difficult to assess why they received 15 percent of the care provided when they represented 21 percent of the population. Although a 6 percent difference does not seem noteworthy, the fact is that public assistance recipients theoretically have no financial barrier to at least some dental care. Two reasons probably account largely for the difference: *(a)* the practices of the limited number of dentists in the area probably are composed largely of private patients who pay much higher fees than does the Pennsylvania Department of Public Welfare and who may be patients of long standing—some of whom may have moved from the area and *(b)* people on public assistance have problems associated with survival to which they give far greater priority than dental care, regardless of the amount of care available. Although these two observations are not unique and the problems are amenable to solution, the steps to be taken are broad and basic and they must include—not be limited to—concern with dental health.

Our final concern is with the goal to be sought regarding recommendations for increasing the dental manpower in a given area. In our study we predicted demand based on data generated previously for use of dental services. A drawback in the application of this mechanism is that it could tend to perpetuate the status quo in low income areas. The mechanism does not improve the dentist-to-population ratio to a level equal to that of more affluent areas for what is thought to be a valid reason, that is, the possibility that the services of a larger number of dentists would not be used rapidly enough to justify their continuation. On the other hand, if the number of dental personnel recommended by this approach were assigned to an area and fully utilized, influential persons would have to reassess the ability of the area to support more dentists and to take appropriate steps. To attain this goal, dental awareness must be heightened in the target population, a pattern for obtaining dental care must be developed, and the economic barrier must be removed.

Conclusion

The prediction of dental manpower need in a low income area based on anticipated use rather than on an arbitrary dentist-to-population ratio seems to be a realistic approach to the identification of dental manpower needs. Final judgment concerning the validity of this approach must await further application and testing of the method.

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