

Introduction

With any type of health care service, having a sufficient number and distribution of providers is critical in ensuring the population can access the care they need. In the dental care sector, there is intense debate both at the federal level as well as in many states concerning the adequacy of the dentist workforce to meet current and future population needs. The Health Resources and Services Administration (HRSA), for example, estimates that there is a current shortage of 6,600 dentists in the United States.¹ Several dental schools that have opened in recent years cite insufficient numbers of dentists as a key factor supporting the need for more dental school graduates.² The aging of the dentist population is another reason commonly put forth as driving a looming shortage of dentists in the United States, with retirements and reduced hours commonly cited as factors driving down the labor supply of dentists.³

The adequacy of the dentist workforce is not simply a supply-side issue. The demand for dental care on the part of the population, the mix of patients in terms of type of payer and geographic location, and a host of other factors all influence the judgment of whether the current and future dentist workforce is sufficient. For example, the aggregate supply of dentists may be judged adequate when compared to the aggregate demand for dental care. However, there may be an insufficient number of dentists relative to need or demand for dental care among disadvantaged populations or in certain geographic areas. The issue of adequacy of the dentist workforce is complex and further conceptual and empirical work is needed. This is true not just of dentistry, but other types of health care services.⁴

In this research brief, we project the number of dentists in Vermont through 2023 based on various modeling scenarios and using the best available data. We do not attempt to make any judgments on the adequacy of the future dentist workforce. This would require much further investigation, incorporating demand side factors, workforce productivity and a host of other factors. Nevertheless, we feel our analysis is a major contribution to the evidence base as it leverages unique data and builds modeling scenarios based on empirical analysis of dentist behavior. In fact, we could not find any published studies that project the supply of dentists at the state level.

Data & Methods

We use three data sources in our analysis. The ADA masterfile is the most up to date information on all dentists in the United States. The masterfile is a database of all dentists, practicing and non-practicing, in the United States and is updated through a variety of methods including reconciliation with state licensure databases, death records, various surveys and censuses of dentists carried out by the ADA. The masterfile is recognized as the most reliable source of information on the dentist population in the United States. We used the masterfile's archived datasets from December of 2003, 2008, and 2013 to gather historical information on the profile of the dentist population for each state, including dentists' ages, dental school graduation years, licensure status, practice location, retirement dates, and deceased dates. This provides us with a "snapshot" for each of our study years. In addition, through various unique identifiers we are able to track critical information for each dentist over time, including his or her practice location, whether they are actually practicing dentistry, whether they are professionally active or retired, and whether they are deceased.

To calculate historical measures of dentists per 100,000 population, we used US Census Bureau state population counts.^{5,6} To calculate future estimates of dentists per 100,000, we combined our future dentist supply modeling results with projections of a state's population from alternative data sources. For Vermont we used a report published by the state government in 2013.⁷ The report contained two options for projecting future population. We selected the state's "Scenario B" for our model because its 2020 projection was most consistent with the US Census Bureau's totals for Vermont's population between

2010 and 2013. We interpolated from the Census Bureau's 2010 population and the state's 2020 and 2030 Scenario B projections to obtain population estimates for the years 2018 and 2023 in our model.

We relied on the ADA's Survey of Dental Education for historical data on the number of graduates of U.S. dental schools.⁸

The state workforce projection model uses historical trends in inflows of dentists to and outflows of dentists from a particular state to inform various modeling assumptions about future inflows and outflows. We defined three outflows of dentists: (1) those who remained active but moved out of state, (2) those who retired or whose license expired, and (3) those who died before retirement. We defined two inflows of dentists: (1) new dental school graduates who located in the state, and (2) established dentists who moved into the state, or dentists already in the state but who renewed an expired license, or came out of retirement. International dentist migration is included in both inflows and outflows.

Seven age groups of dentists are analyzed separately, to capture important differences in behaviors (e.g., propensity to relocate or retire). The age groups were: under 35, 35 to 44, 45 to 54, 55 to 64, 65 to 74, 75 to 84, and 85 to 99.

Historical data on inflows and outflows are analyzed across two five-year periods, 2003 to 2008 and 2008 to 2013. Given that we found important differences in dentist behavior across these two historical periods, we also use a ten-year period of 2003 to 2013 in our modeling. The 2008-2013 period covers a major economic downturn in the U.S., which has significantly affected the dental care sector and could lead to changes in dentist behavior, namely retirement patterns. Dentist earnings and busyness levels, for example, have declined.⁹ At the same time, some analysis suggest that much more permanent changes are occurring in the dental care sector, and dentist behavior may not revert back to pre-Great Recession patterns once the economy rebounds.¹⁰ As a result, we feel it is important to distinguish these three distinct timeframes in our analysis.

For each of the three time periods, we calculate rates for each type of inflow and outflow in our model. We do this separately for each age group. For example, we take all dentists in the state who were ages 55 to 64 in 2008 and calculate the proportion who remained in the state but were retired in 2013. This provides a retirement rate for the 55 to 64 age group for the period 2008-2013. We also calculate the proportion who were deceased in 2013 as well as the proportion who were practicing in another state in 2013. Because we know the year of graduation of every dentist in the U.S., we are able to calculate the proportion of all dental school graduates from the classes of 2008 to 2013 who are located in the state in 2013. This provides an inflow rate for dental school graduates.

To project the number of dentists in a state in 2018 we first began with the number of dentists in the state as of December 2013. We then projected future outflows and inflows for two five-year periods: 2013 to 2018 and 2018 to 2023. For the outflows, we apply age-group specific rates of out-migration, retirement, and death before retirement to the 2013 dentist population. We use three scenarios, corresponding to the historical rates for 2003-2008, 2008-2013, and 2003-2013.

For Vermont, in most age groups, we chose to apply the historical percentages from the period 2003-13. For ages 85 and older we applied a custom retirement percentage higher than Vermont's historical percentage to compensate for an unusual historical percentage derived from a low number of dentists.

To model the inflows, we first estimate the total number of U.S. dental school graduates in 2013-2018 and 2018-2023. We use two scenarios. The first is that the number of graduates will increase linearly through 2018 and will then remain flat. The second scenario is that the number of graduates will increase linearly through 2023. For the purposes of the Vermont analysis, we only use the second scenario. The future number of dental school graduates is subject to intense debate and speculation. On one hand, there are several new dental schools that have either recently opened or are in the planning stages.¹¹ On the other hand, the flattening of dentist earnings in recent years¹² could place downward pressure on the number of dental school applicants, as suggested in previous research.^{13,14} We take this projected number of dental school graduates and apply historical percentages, by age group, of new graduates who end up locating

in the state. This provides an estimate of the inflow from the class of 2013-2018 dental school graduates expected to locate in the state.

In-migration of dentists into the state is another source of inflows. We start by estimating the total number of dentists in the U.S, by age group, in 2013. For those who were active but located in another state in 2013, we calculated their age in 2018, estimated the proportion remaining active in 2018, and of those, how many are expected to move into to the state between 2013 and 2018. Again, this was done separately for each age group. These estimates were based simply on historical migration rates from 2003-2008, 2008-2013, and 2003-2013. It is important to note that this in-migration estimate also captures dentists within the state who re-activated their license or un-retired during the period, but these groups constitute a very small portion of the total inflow. As a result, we do not analyze them separately and for simplification purposes, we call this category of inflow in-migration.

Results

There were 368 practicing dentists in Vermont as of December 2013. This translates to 58.7 per 100,000.

Our baseline modeling scenario uses historical data from 2003-2013 to estimate rates of inflows and outflows. This scenario assumes the number of dental school graduates will grow linearly from 2013 to 2023.

We estimate that 287 dentists will remain in Vermont and will continue to practice in 2018. We estimate 33 new dental school graduates from the classes of 2013-2018 will locate in Vermont and an additional 37 dentists who were practicing in other states in 2013 will move to Vermont by 2018. As a result, we estimate there will be 357 practicing dentists in Vermont in 2018. Iterating the model once more, we estimate there will be 349 practicing dentists in Vermont in 2023. Combining these results with population projections, we estimate there will be 56.8 and 55.7 practicing dentists per 100,000 population in Vermont in 2018 and 2023, respectively.

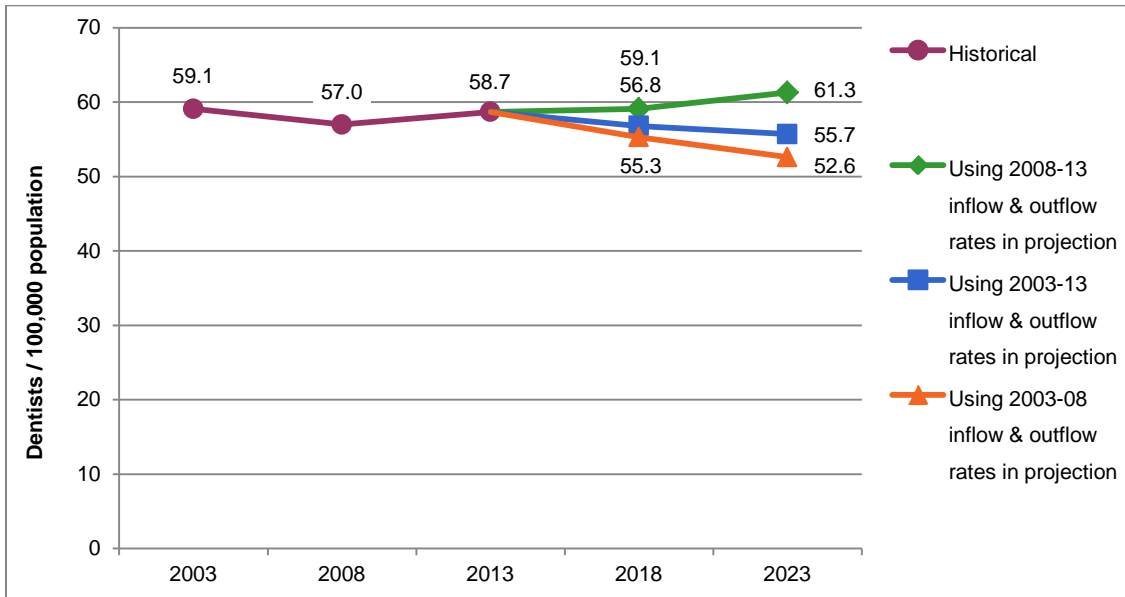
Using the historical data from 2003-2008 and 2008-2013 to estimate rates of inflows and outflows produces two alternative modeling estimates. The estimated number of dentists per 100,000 population under these two alternative scenarios are shown in Figure 1.

Table 1 and Figure 2 show the historical and projected age distribution of dentists in Vermont from 2003 to 2013 (historical) and 2013 to 2023 (projected).

Given the high degree of speculation concerning the future number of dental school graduates, we modeled a fourth scenario where we assumed the number of dental school graduates in the U.S. will grow linearly through 2018 after which it will remain constant through 2023. Table 2 shows the modeling results from this scenario.

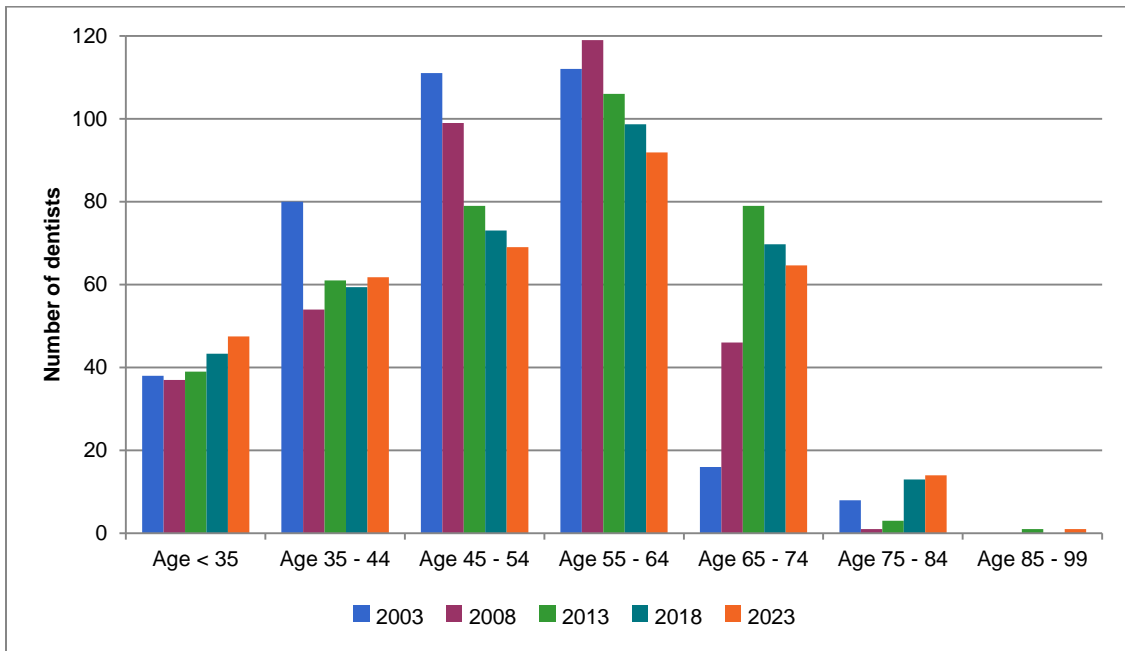
Finally, Table 3 summarizes the estimated annual inflows and outflows, as well as the additional net inflow per year required in order to maintain a constant number of dentists per 100,000 population through 2023. For Vermont, an additional net inflow of about 2 dentists per year is needed in order to maintain 58.7 dentists per 100,000 population, the 2013 level.

Figure 1: Historical and Projected Dentists per 100,000 Population, Vermont



Source: ADA Health Policy Resources Center analysis of ADA masterfile; US Census Bureau, State Intercensal Estimates and State Total Population Estimates; Vermont Agency of Commerce and Community Development.
Notes: Data for 2003, 2008, and 2013 are based on the ADA masterfile. Results for 2018 and 2023 are projected.

Figure 2: Age Distribution of Dentist Workforce in Vermont, 2003 - 2023



Source: ADA Health Policy Resources Center analysis of ADA masterfile; US Census Bureau, State Intercensal Estimates and State Total Population Estimates; Vermont Agency of Commerce and Community Development.
Notes: Data for 2003, 2008, and 2013 are based on the ADA masterfile. Results for 2018 and 2023 are projected.

Table 1: Age Distribution of Vermont Dentist Workforce, 2003 - 2023

Age group	2003	2008	2013	2018	2023
Age < 35	38	37	39	43	47
Age 35 - 44	80	54	61	59	62
Age 45 - 54	111	99	79	73	69
Age 55 - 64	112	119	106	99	92
Age 65 - 74	16	46	79	70	65
Age 75 - 84	8	1	3	13	14
Age 85 - 99	0	0	1	0	1
Total	365	356	368	357	349
Vermont population	617,858	624,151	626,630	628,099	626,226
DDS / 100,000 population	59.1	57.0	58.7	56.8	55.7

Source: ADA Health Policy Resources Center analysis of ADA masterfile; US Census Bureau, State Intercensal Estimates and State Total Population Estimates; Vermont Agency of Commerce and Community Development.

Notes: Data for 2003, 2008, and 2013 are based on the ADA masterfile. Results for 2018 and 2023 are projected. Totals in projected years may not match the sum of age groups due to the rounding of fractional numbers produced by the model.

Table 2: Dentist Workforce Projection, Vermont

	2003	2008	2013	2018	2023
Scenario 1 – Assumes number of dental school graduates will increase linearly through 2018 and then remain constant					
Total dentists	365	356	368	357	347
Dentists / 100,000 population	59.1	57.0	58.7	56.8	55.4
Scenario 2 – Assumes number of dental school graduates will increase linearly through 2023. This scenario is used in the final results.					
Total dentists	365	356	368	357	349
Dentists / 100,000 population	59.1	57.0	58.7	56.8	55.7

Source: ADA Health Policy Resources Center analysis of ADA masterfile; US Census Bureau, State Intercensal Estimates and State Total Population Estimates; Vermont Agency of Commerce and Community Development.

Note: Data for 2003, 2008, and 2013 are based on the ADA masterfile. Results for 2018 and 2023 are projected.

Table 3: Dentist Workforce Projection Inflows and Outflows, Vermont

	2003 - 2008	2008 - 2013	2013 - 2018	2018 - 2023	2013 - 2023
Average outflow of dentists per year	12.6	12.2	16.2	16.6	16.4
Average inflow of dentists per year	10.8	14.6	14.0	15.0	14.5
Additional dentists needed above the projection, per year, to maintain 58.7 dentists per 100,000 population			2.4	1.4	1.9

Source: ADA Health Policy Resources Center analysis of ADA masterfile; US Census Bureau, State Intercensal Estimates and State Total Population Estimates; Vermont Agency of Commerce and Community Development.

Notes: Data up to 2013 are based on the ADA masterfile. Results after 2013 are projected. "Additional dentists" are in addition to those already predicted to start practicing in the state as part of the inflows from the projection model.

Discussion

Based on our analysis, there are clearly a variety of estimates of the future number of dentists in Vermont. These estimates, of course, are subject to a high degree of uncertainty as they are based on several assumptions. Nevertheless, we know of no other source of such estimates. We also feel that our approach is, while remaining simple, well-informed and is suitable given the available data.

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